Chapter: 20

State(s): Washington

Recovery Unit Name: Lower Columbia

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and/or protect the species. Recovery plans are prepared by the U.S. Fish and Wildlife Service and, in this case, with the assistance of recovery unit teams, State and Tribal agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views or the official positions or indicate the approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. Recovery plans represent the official position of the U.S. Fish and Wildlife Service *only* after they have been signed by the Director or Regional Director as *approved*. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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Members of the Lower Columbia Recovery Unit Team that contributed to the preparation of this chapter include:

Lower Columbia Recovery Unit Team:

Frank Shrier, PacifiCorp
Steve Lanigan, U.S. Forest Service, Gifford-Pinchot National Forest
Jim Byrne, Washington Department of Fish and Wildlife
Joe Hiss, U.S. Fish and Wildlife Service
Gene Stagner, U.S. Fish and Wildlife Service
Tim Cummings, U.S. Fish and Wildlife Service

Additional review and comments were provided by:

John Weinheimer, Washington Department of Fish and Wildlife
Gary Wade, Lower Columbia Fish Recovery Board
Jim Uehara, Washington Department of Fish and Wildlife
Jeff Breckel, Lower Columbia Fish Recovery Board
Terry Jackson, Washington Department of Fish and Wildlife
Steve Stampfli, Underwood Conservation District
Bao Le, U.S. Fish and Wildlife Service
Donna Allard, U.S. Fish and Wildlife Service

LOWER COLUMBIA RECOVERY UNIT CHAPTER OF THE BULL TROUT RECOVERY PLAN

EXECUTIVE SUMMARY

CURRENT SPECIES STATUS

The Fish and Wildlife Service issued a final rule listing the Columbia River and Klamath River populations of bull trout (*Salvelinus confluentus*) as a threatened species under the Endangered Species Act on June 10, 1998 (63 FR 31647). The Columbia River Distinct Population Segment is threatened by habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, and past fisheries management practices such as the introduction of nonnative species.

The Lower Columbia Recovery Unit Team identified two core areas (Lewis and Klickitat rivers) within the recovery unit. The Lewis Core Area includes the mainstem Lewis River and tributaries downstream to the confluence with the Columbia River, with the exclusion of the East Fork of the Lewis River. The Klickitat Core Area includes all tributaries downstream to the confluence with the Columbia River. Based on survey data and professional judgement**,** the Lower Columbia Recovery Unit Team has also identified local populations of bull trout within the core areas. Local populations within the Lower Columbia Recovery Unit are currently contained in Cougar, Pine, and Rush creeks (Lewis River), and in the West Fork of the Klickitat River. While no local populations within the White Salmon River have been identified, this system contains core habitat, and after reconnection with the Columbia River could support bull trout.

Historically, bull trout may have inhabited areas within the Cowlitz and Kalama rivers, but current distribution within the basin is unknown. The Cowlitz and Kalama rivers are considered research needs and additional information is required to determine if each respective system is important for bull trout recovery.

Fluvial bull trout in the Lower Columbia Recovery Unit, could have migrated seasonally from tributaries downstream into the Columbia River to overwinter and feed. Bull trout in other Columbia River tributaries (*e.g.*, Hood and Wenatchee rivers) are known to migrate downstream to the mainstem Columbia River as part of their normal life history strategies. However, the extent to which bull trout in the Lower Columbia Recovery Unit currently use the mainstem Columbia River is unknown. The Lower Columbia Recovery Team considers the mainstem Columbia River to contain core habitat which may be important for full recovery to occur. Studies designed to verify bull trout abundance, spatial distribution, and temporal use of the mainstem Columbia River are considered a primary research need.

Key information gaps that need to be addressed in the Lower Columbia Recovery Unit include: (1) specific information on the suitability of potential spawning and rearing areas in each basin, (2) increased inventory in each basin to establish the current distribution, and (3) a complete limiting factors analysis to identify site specific actions needed to recover bull trout within each system. Information from each of these tasks is essential in order to define the recovered distribution and abundance in each basin. The Lower Columbia Recovery Unit Team believes that it is essential that these efforts be coordinated with local government entities and watershed councils.

HABITAT REQUIREMENTS AND LIMITING FACTORS

A detailed discussion of bull trout biology and habitat requirements is provided in Chapter 1 of this recovery plan. The limiting factors discussed here are specific to the Lower Columbia Recovery Unit Chapter. Within the Lower Columbia Recovery Unit, historic and current land use activities have impacted bull trout local populations. Dams have fragmented bull trout habitat, isolated local populations, and prevented access to historical foraging and overwintering habitat. Forest management activities have altered habitat conditions in portions of the recovery unit; impacts to bull trout result from impassable culverts, excessive erosion and sedimentation, reduced recruitment of large woody debris, channel changes, and altered water temperatures, instream flow, and runoff

patterns. Grazing has resulted in eroded stream banks, increased sedimentation, and incised stream channels. Water withdrawals for agriculture reduce instream flows and result in increased water temperatures. Nonnative species pose a threat to bull trout through potential hybridization, competition for resources, and predation.

RECOVERY GOALS AND OBJECTIVES

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range, so that the species can be delisted.** To achieve this goal the following objectives have been identified for bull trout in the Lower Columbia Recovery Unit.

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Lower Columbia Recovery Unit.

- Maintain stable or increasing trends in abundance of bull trout.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.

- Conserve genetic diversity and provide opportunity for genetic exchange.

RECOVERY CRITERIA

Recovery criteria for the Lower Columbia Recovery Unit were established to assess whether actions are resulting in the recovery of bull trout in the basin. Recovery criteria identified for the Lower Columbia Recovery Unit are as follows.

1. **The recovered distribution of bull trout in the Lower Columbia Recovery Unit is unknown and considered a research need. Until additional information is obtained, at a minimum, the four existing local populations in the recovery unit need to be maintained.** Current

local populations are Rush and Pine creeks (Swift Creek Reservoir) and Cougar Creek (Yale Lake) in the Lewis Core Area; and the West Fork Klickitat River in the Klickitat Core Area. These local populations need to be maintained while studies are initiated to identify additional local populations. The establishment of additional local populations in the Lewis Core Area is essential for recovery. Potential local populations in the Lewis (*e.g.*, Speelyai, Rain, Ole creeks, Swift by-pass reach, and upper mainstem Lewis River) have already been identified and research should be directed at factors limiting reintroduction. Other potential sites within the Lewis Core Area which have, or could support suitable habitat conditions if restored should also be evaluated. While the White Salmon River is recognized as historic core habitat, and necessary for recovery, specific tributaries where local populations could occur is unknown. Similarly, additional spawning and rearing areas within the Klickitat River have not been identified. Studies in the White Salmon and Klickitat rivers should assess the potential habitat suitability and productive capacity of tributaries that could support local populations. Subsequently, factors that may limit the reintroduction potential should be identified, and corrective restoration activities or management actions should be implemented. Reestablishment of local populations within the White Salmon and Klickitat rivers may require the use of artificial propagation and would follow Federal policy and guidelines. The Lower Columbia Recovery Team recommends that studies be initiated to determine the effectiveness and feasibility of using fish transfers and hatcheries to assist in any future reintroduction efforts. Potential local populations should be identified within 3 years and actions needed to implement reintroduction efforts will be incorporated in the review of the Lower Columbia River Recovery Unit plan.

2. **Estimated abundance of bull trout among all local populations under a recovered condition in the Lower Columbia Recovery Unit is considered a research need.** Uncertainty surrounding the number of local populations under a recovered condition in each core area precluded determination of the recovered abundance estimate in the Lower Columbia

Recovery Unit. As more data is collected, recovered population estimates will be identified to more accurately reflect both the migratory and resident life history components. In determining the recovered abundance, consideration of genetic risk, effective population size, and connectivity need to be incorporated with habitat productivity estimates in order to determine achievable abundance goals.

3. **Adult bull trout exhibit a stable or increasing trend for at least two generations at or above the recovered abundance level within core areas.** The development of a standardized monitoring and evaluation program which would accurately describe trends in bull trout abundance is identified as a priority research need. As part of the overall recovery effort, the U.S. Fish and Wildlife Service will take the lead in addressing this research need by forming a multi-agency technical team to develop protocols necessary to evaluate trends in bull trout populations.

4. **Specific barriers to bull trout migration in the Lower Columbia Recovery Unit have been addressed.** The barriers that are identified as primary impediments to recovery, and where connectivity must be reestablished, are at Swift (Number 1 and 2) and Yale dams on the Lewis River; and Condit Dam on the White Salmon River. Identification of these barriers does not imply that other actions associated with passage (*e.g.*, culverts), habitat degradation, or nonnative species control are not crucial for recovery to occur.

The Lower Columbia Recovery Unit Team expects that the recovery process will be dynamic and will be refined as more information becomes available. Recovery criteria developed for bull trout address quantitative measurements of bull trout distribution and population characteristics. The recovery objectives were based on our current knowledge and may be refined as more information becomes available. Future adaptive management will play a major role in recovery implementation and refinement of recovery criteria. While removal of bull trout as a species under the Act (*i.e.*, delisting) can only occur for

the entity that was listed (Columbia River Distinct Population Segment), the recovery unit criteria listed above will be used to determine when the Lower Columbia Recovery Unit is fully contributing to recovery of the population segment.

ACTIONS NEEDED

Recovery for bull trout will entail reducing threats to the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life-history forms. Specific tasks falling within seven categories of actions needed are discussed in Chapter 1, tasks specific to this recovery unit are provided in this chapter.

ESTIMATED COST OF RECOVERY

Total estimated cost of bull trout recovery in the Lower Columbia Recovery Unit is $8 million. This estimate does not include costs associated with capital improvements associated with recommended fish passage measures at Swift, Yale, Merwin, and Condit dams. Estimates for construction cost for passage at these facilities are an outcome of recommended actions. Total costs include estimates of expenditures by local, Tribal, State, and Federal governments and by private business and individuals. Cost estimates are not provided for tasks that are normal agency responsibilities under existing authorities. Successful recovery of bull trout in the Lower Columbia Recovery Unit is contingent on removing barriers, improving habitat conditions, and control of non-native species. These costs are attributed to bull trout conservation, but other aquatic species will also benefit.

ESTIMATED DATE OF RECOVERY

Time required to achieve recovery depends on bull trout status, factors affecting bull trout, implementation and effectiveness of recovery tasks, and responses to recovery tasks. A tremendous amount of work will be required to

restore impaired habitat, reconnect habitat, and eliminate threats from nonnative species. Three to five bull trout generations (15 to 25 years), or possibly longer, may be necessary before identified threats to the species can be significantly reduced and bull trout can be considered eligible for delisting. In the Lower Columbia Recovery Unit bull trout currently exist in very low numbers. Degradation and fragmentation of bull trout habitat have resulted in populations that are at high risk. Ultimately, these threats must be addressed in the near future if recovery will be achieved.

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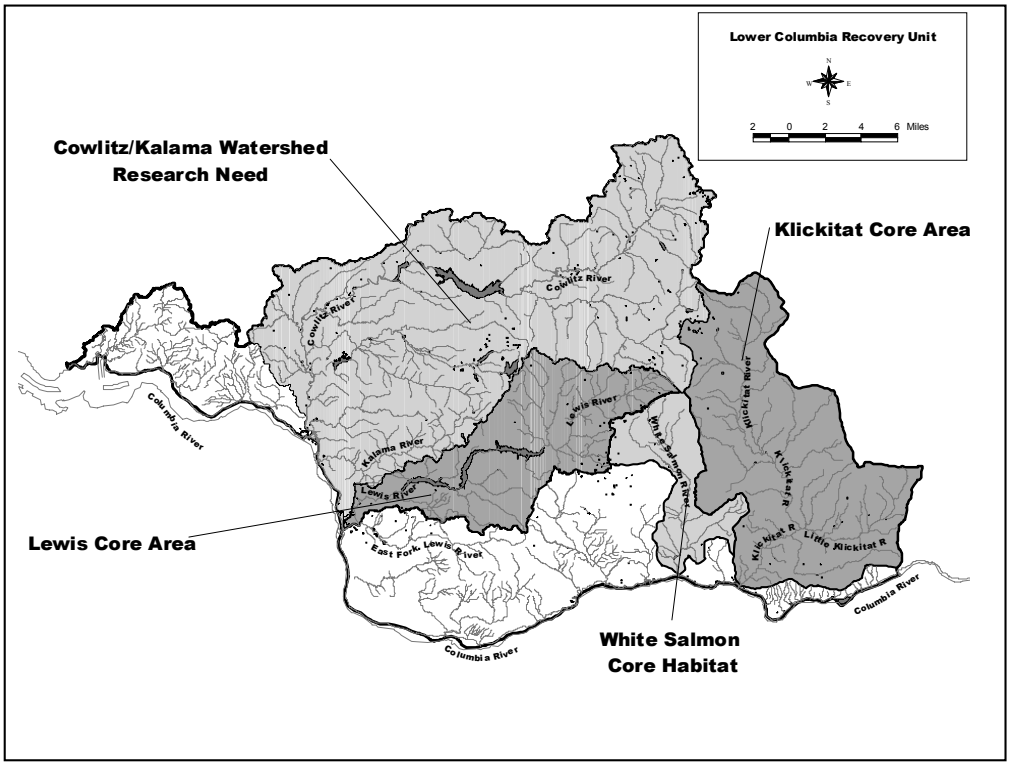
INTRODUCTION

Recovery Unit Designation

The Lower Columbia Recovery Unit is 1 of 22 recovery units designated for bull trout in the Columbia River basin (Figure 1). Recovery units were identified based on three factors: (1) recognition of jurisdictional boundaries, (2) biological and genetic factors common to bull trout within a specific geographic area, and (3) logistical concerns for coordination, development, and implementation of the recovery plan. In Washington, to facilitate the recovery planning process and avoid duplication of effort, the recovery team has adopted the logistical framework proposed in the 1999 draft Statewide strategy to

Figure 1. Bull Trout Recovery Units in the United States. The Lower Columbia Recovery Unit is highlighted.

Figure 2. Lower Columbia Recovery Unit (Lewis and Klickitat core areas, and White Salmon River) for bull trout in Washington.



recover salmon "Extinction Is Not An Option" (WGSRO 1999). Based on this draft strategy, bull trout recovery units overlap the State's salmon recovery regions. The identification of Lower Columbia, Middle Columbia, Upper Columbia, Snake, and Northeast Washington recovery units will allow for better coordination during both salmon and bull trout recovery planning and implementation.

The Lower Columbia Recovery Unit Team identified two core areas (Lewis and Klickitat rivers) within the recovery unit (Figure 2). Based on survey data and professional judgement, the Lower Columbia Recovery Unit Team has also identified local populations of bull trout within the core area. Local populations within the Lower Columbia Recovery Unit are currently contained in Cougar, Pine, and Rush creeks (Lewis River), and in the West Fork of the Klickitat River. While no local populations within the White Salmon River have

been identified, this system contains core habitat, and after reconnection with the Columbia River will support bull trout.

This recovery unit geographically overlaps ceded lands of the Yakama Nation. The Yakama Nation have guaranteed Treaty fishing rights for both anadromous and resident fish species. When the Lower Columbia Recovery Unit has achieved its goal, the Washington Department of Fish and Wildlife and the Yakama Nation will determine the location and level of bull trout harvest which can be sustained while maintaining healthy populations.

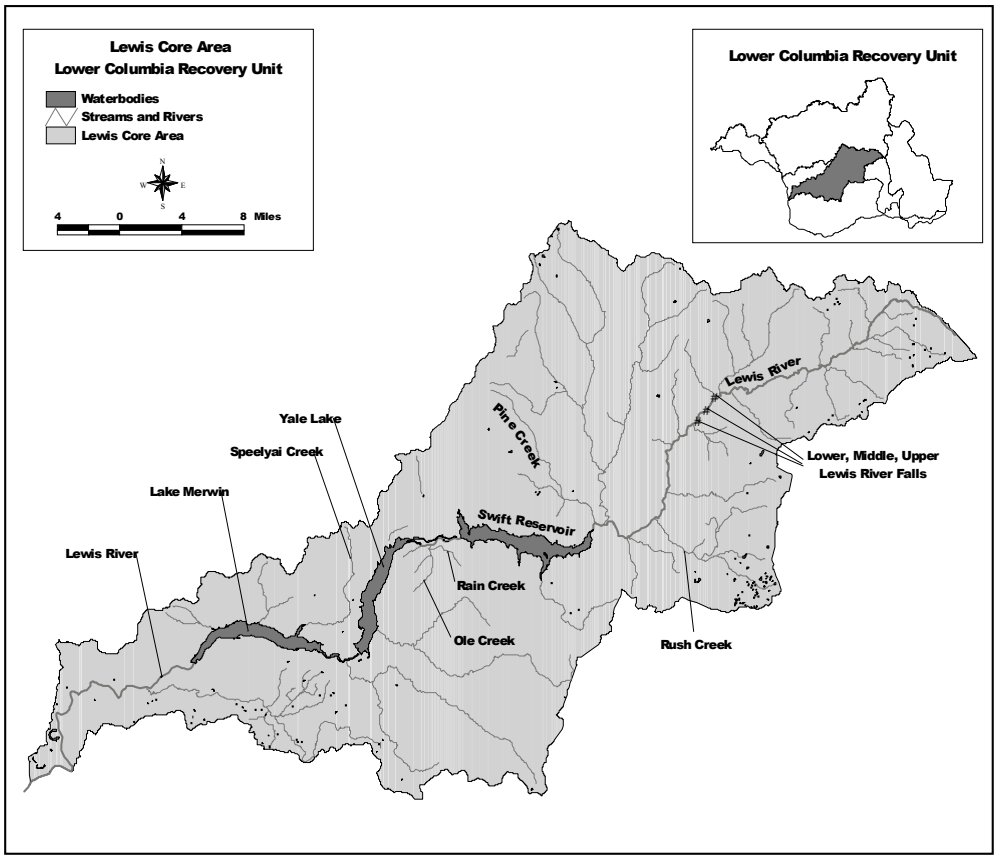
Geographic Description

Lewis Core Area

The Lewis Core Area is located on the western flanks of the Cascade Mountains in southwest Washington State. The Lewis Core Area includes the mainstem Lewis River and tributaries downstream to the confluence with the Columbia River, with the exclusion of the East Fork of the Lewis River (Figure 3). The northern and southern boundaries are defined by the crests of the drainage basin. Approximately 16 kilometers (10 miles) above Swift Reservoir, a series of three natural barrier falls on the Lewis River prevents upstream fish movement.

The region surrounding the Lewis River basin has a complex geologic history, having undergone volcanic activity, several glaciations, and glacial erosion and deposition. The river drains a 2719 square kilometer (1,050 square mile) area, flowing 150 kilometers (93 miles) southwestwardly before it joins with the Columbia River (PacifiCorp 2000a, WSCC 2000a). The major climatic influences are the proximity of the Pacific Ocean, terrain features, and alternating high and low pressure regions over the ocean. Average annual precipitation varies from 115 centimeters (45 inches) near Woodland to over 359 centimeters (140 inches) on nearby Mt. Adams (PacifiCorp 2000a).

Figure 3. Lewis Core Area for bull trout and selected tributaries.



The eruption of Mt. St. Helens affected water quality in the Muddy River and Pine Creek. Riparian vegetation was destroyed and mud flows and ash deposits have contributed high levels of fine sediments to Pine Creek, Muddy River, and the Lewis River above Swift Creek Reservoir (PacifiCorp 2000a). Stream temperatures above 16 degrees Celsius (61 degrees Fahrenheit) have also been measured in Pine Creek although the most current data collected did not exceed 14.3 degrees Celsius in addition to increase sediment input, elevated stream temperatures have also been observed. While the exact cause of these elevated stream temperatures are not well understood, it is suspected that channel widening from high levels of timber harvest, and the 1980 mudflows and the loss of riparian vegetation from the St. Helens eruption, have all contributed to elevated stream temperatures in Pine Creek (USFS 1996).

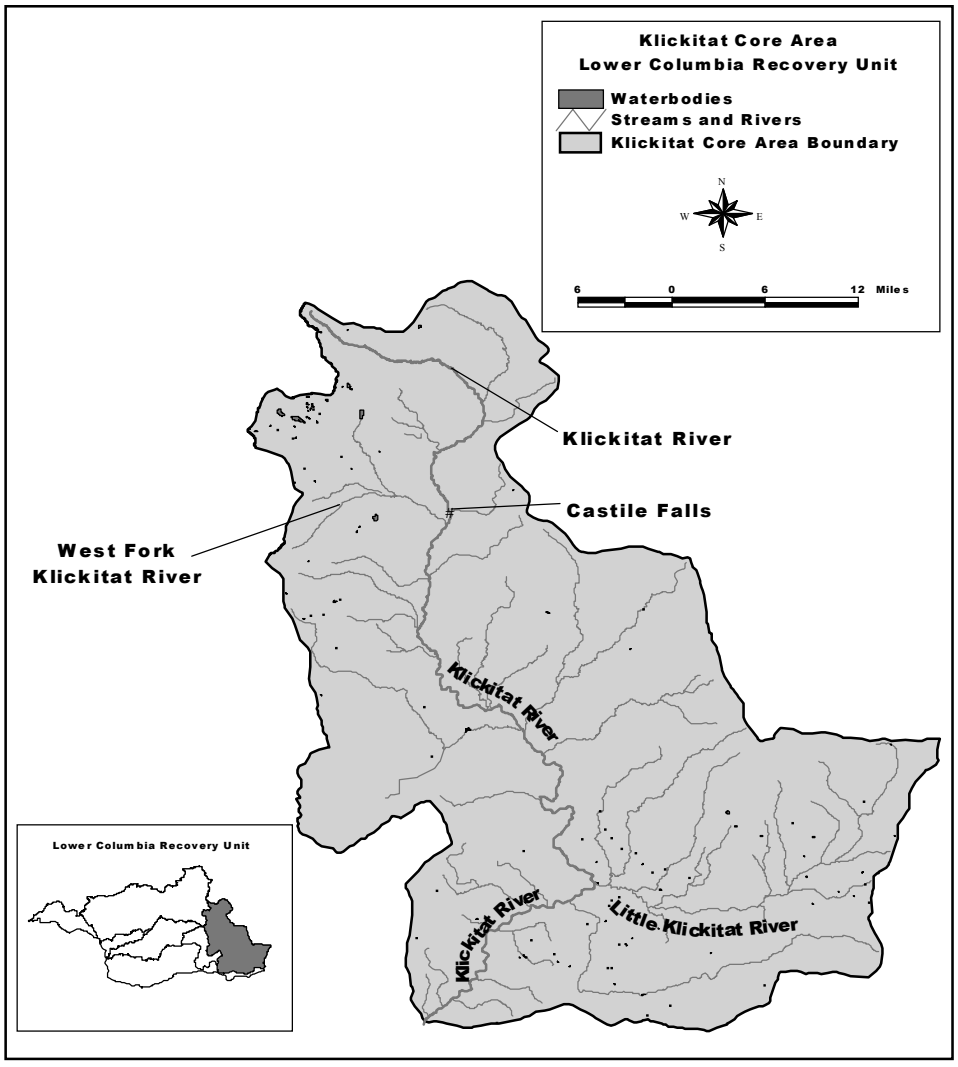
In the upper river, median monthly flows reach their highest levels during the May and June runoff period at 33 cubic meters per second (1,170 cubic feet per second), then fall to low values of approximately 4 cubic meters per second (138 cubic feet per second) in September (PacifiCorp 2000a). By contrast, median natural flows in the lower river (Ariel Gauge), can reach a high of 165 cubic meters per second (5,860 cubic feet per second) in February, demonstrating the dominance of rainfall in this portion of the basin. The lowest median monthly flow in the lower river (near Ariel) occurs in September (950 cubic feet per second or 27 cubic feet per second). The highest monthly maximum flow in the upper river (near Trout Lake) was nearly 221 cubic meters per second (7,800 cubic feet per second) in December, while the highest monthly maximum flow in the lower river at Ariel was over 1,460 cubic meters per second (51,600 cubic feet per second) in November.

Klickitat Core Area

The Klickitat River (Figure 4) is located on the east slope of the Cascade Range in Washington and drains approximately 3,496 square kilometers (1,350 square miles)(NPPC 2000a). The Klickitat River is the longest free flowing river in the Northwest, flowing about 153 kilometers (95 miles) before its confluence with the Columbia River at River kilometer 290 (River Mile 180). Major tributaries include Swale Creek at River kilometer 28 (River Mile 17.2), Little Klickitat River at River kilometer 32 (River Mile 19.8), Outlet Creek at River kilometer 64 (River Mile 39.7), Big Muddy Creek at River kilometer 87 (River Mile 53.8), West Fork Klickitat River at River kilometer 102 (River Mile 63.1) and Diamond Fork Creek at River kilometer 124 (River Mile 76.8). In 1986, the lower 16 kilometers (10 miles) of the mainstem Klickitat were identified as processing unique and outstanding recreational values under the Wild and Scenic River Act (NPPC 2000a). Castile Falls at River kilometer 103 (River Mile 64) may be a barrier for upstream migration of bull trout on the mainstem Klickitat (WDFW 2001a).

Within the Klickitat basin, the Cascade Crest is dominated by the 3,659 meter (12,000 foot) Mt. Adams and the associated glacial system which drains the Klickitat River. Many portions of the basin are characterized by deep, steep-walled canyons with a constrained floodplain. The mainstem Klickitat originates from the Cascades below Cispus Pass at an elevation of approximately 1,524 meters (5,000 feet) and flows to its confluence with Bonneville Pool on the Columbia River at an approximate elevation of 22.6 meters (74 feet) above sea level.

Figure 4. Klickitat Core Area for bull trout and selected tributaries.



Climate within the Klickitat basin is characterized as a hybrid of conditions found on the east and west sides of the Cascades (WSCC 2001). Due to the Klickitat's position at the head of the Columbia Gorge, the basin receives a stronger marine influence than other east side basins. Summers are typically hot and dry with average temperatures ranging from 13 to 21 degrees Celsius (55 to 70 degrees Fahrenheit), and winters are normally cold and wet with average temperatures ranging from minus 4 to 3 degrees Celsius (25 to 37 degrees Fahrenheit). Average precipitation ranges from 359 centimeters (140 inches) on Mt. Adams to 38 centimeters (15 inches) in the southeastern portion of the basin (WSCC 2001).

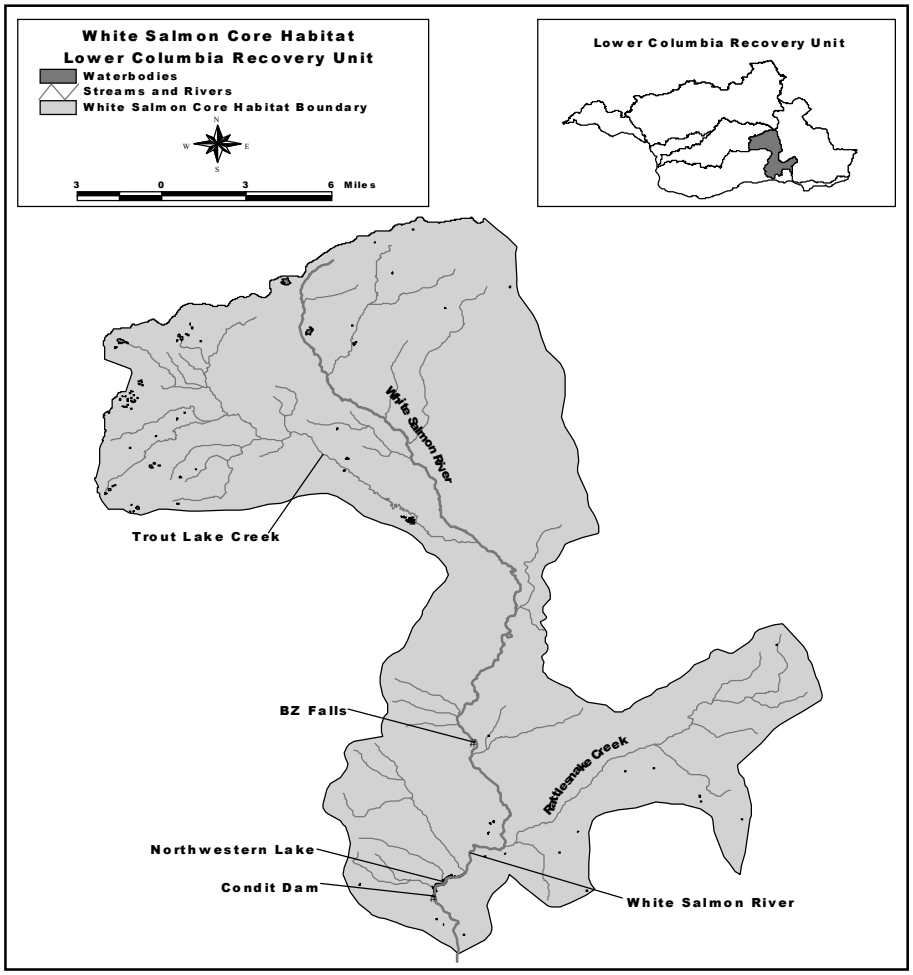
The Klickitat basin is approximately equally divided between Klickitat and Yakima counties. The Yakama Nation Reservation occupies the northern 56 percent of the watershed (WSCC 2001). Approximately 90 percent of the non-reservation land is under private ownership. The remaining 10 percent of the land base is predominately State owned and managed by the Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and to a lesser degree the U.S. Fish and Wildlife Service. Major land use activities within the basin include commercial timber production, grazing, and agricultural production. Major private landholders within the basin include Champion International and Boise Cascade (NPPC 2000a).

White Salmon River

The White Salmon River originates on the southwestern slope of Mount Adams (Figure 5). The river flows south for 73 kilometers (45 miles), draining a basin of approximately 1,000 square kilometers (386 square miles) before entering Bonneville Pool on the Columbia River (NPPC 1990). Condit Dam is located at River kilometer 5.3 (River Mile 3.3) and forms Northwestern Lake. Major tributaries upstream of Northwestern Lake include Rattlesnake and Trout Lake creeks. Tributaries that enter Northwestern Lake include Buck, Mill, and Little Buck creeks. No significant tributaries enter the White Salmon River downstream of Condit Dam.

Elevations in the basin range from 22 to 3752 meters (72 to 12,307 feet), and basin stream gradients are fairly steep with numerous waterfalls (PacifiCorp 1991, NPPC 1990). The river flows through a steep gorge from River kilometer 35 to 19 (River Mile 22 to 12) that contains several waterfalls up to 7 meters (21 feet) in height. Farther downstream, there is approximately a 3 meter (10 foot) drop at Husum Falls. Waterfalls, with heights ranging from 4.6 to 15.2 meters (15 to 50 feet), also occur near the mouths of many tributaries. Falls at River kilometer 26 (River Mile 16) are thought to be barriers to anadromous salmon and bull trout upstream migration.

Figure 5. White Salmon River core habitat for bull trout.



The White Salmon River Basin lies on a climatic transition zone between the Southern Washington Cascade and Columbia Basin physiographic provinces (Franklin and Dyrness 1973). The winters are wet and the summers are relatively dry. Average annual precipitation is 127 centimeters (49.4 inches), of which 85 percent occurs from October through March (NPPC 1990).

Federal, State, and private entities own land in the basin. Approximately 47 percent of the headwaters of the basin are in the Gifford Pinchot National Forest (NPPC 1990). The remaining land is either state land, managed by the Washington Department of Natural Resources, or is privately owned. The White Salmon River is located within portions of four land-use planning jurisdictions: Klickitat County, Skamania County, U.S. Forest Service, and the Columbia River Gorge Commission (PacifiCorp 1991). The White Salmon River upstream of Northwestern Lake from River kilometer 8 to 20 (River Mile 5.0 to 12.7) is part of the National Wild and Scenic Rivers system (UCD 1994, USFS 1998). The portion of the river downstream of Northwestern Lake from River kilometer 5.3 (River Mile 3.3) to the mouth is included in the Columbia River Gorge National Scenic Area.

Principal land uses in the basin are timber production, range, and agriculture. Agricultural areas are concentrated in Trout Lake Valley and along the river valley between BZ Corner and White Salmon. Approximately 1,822 hectares (4,500 acres) in the basin are cultivated, with the majority occurring in the Trout Lake Valley (NPPC 1990).

Stream flows in the basin are a combination of rain, snow and glacial melt, and groundwater (PacifiCorp 1991). The mean monthly discharge at the mouth of the White Salmon River from 14 cubic meters per second (487 cubic feet per second) in fall to 43 cubic meters per second (1,511 cubic feet per second) in spring. Flows for the 100-year flood are approximately 385 cubic meters per second (13,600 cubic feet per second). The highest flood on record occurred in February 8, 1996, and was approximately 1,279 cubic meters per second (45,200 cubic feet per second) (USGS *in litt.* 2002).

DISTRIBUTION AND ABUNDANCE

Status of Bull Trout at the Time of Listing

The U.S. Fish and Wildlife Service identified four "subpopulations" within the Lower Columbia Recovery Unit, two are within the Lewis River, Yale Lake and Swift Creek Reservoir, and one subpopulation in the White Salmon and Klickitat respectively (USFWS 1998a). In the listing rule the U.S. Fish and Wildlife Service considered each subpopulation to be depressed. Threats to long-term persistence included dams, forest management practices, roads, agricultural practices, grazing, and nonnative species. Although subpopulations were an appropriate unit upon which to base the 1998 listing decision, the recovery plan has revised the biological terminology, to better reflect both current understanding of bull trout life history and conservation biology theory. Therefore, subpopulation terms will not be used in this chapter. Habitat and population terminology is found in Chapter 1.

Current Distribution and Abundance

Lewis Core Area

Currently, reproducing populations of bull trout within the Lewis River Core Area are found in Lake Merwin, Yale, and Swift Creek reservoirs (Figure 3). The number of bull trout inhabiting the Lewis Core Area is believed to be low. Spawning and juvenile rearing occurs in Cougar Creek (Yale Lake), and in Rush and Pine creeks (Swift Creek Reservoir). Additionally, subadults have been observed in the Swift Number 2 by-pass reach and the Swift Creek arm of Swift Creek Reservoir (PacifiCorp 1999). Bull trout in the Lewis River are considered to be predominately adfluvial. During 2001, catch reports of two bull trout initially indicated that a resident population may exist in the upper Lewis River. However, recent visual evidence indicates that these fish may have been misidentified (J. Byrne, Washington Department of Fish and Wildife, pers. comm. 2002). Dolly Varden, or bull trout, were known to occur in the Muddy River (WDG 1957). However, it is unknown whether bull trout used the system for spawning and rearing.

Throughout their range, adfluvial bull trout mature for 2 or 3 years in lakes and reservoirs before undergoing spawning migrations (usually at 4 to 7 years of age). Spawning generally occurs in late summer to early fall as water temperatures begin to drop (Goetz 1989). In the Lewis Core Area, bull trout residing in Swift Creek Reservoir migrate into tributary streams from late May through early August, and spawn from early August through the middle of September (Faler and Bair 1991; Graves 1983; PacifiCorp 2000b, 2001, 2002). Emigration of juveniles from the tributaries to Swift Creek Reservoir and Yale Lake is believed to occur from the middle of May through June (PacifiCorp 2002).

Genetic samples were taken from Lake Merwin, Yale Lake, and Swift Creek Reservoir in 1995 and 1996. Analysis showed that Lewis River basin bull trout were genetically similar to coastal populations in the Columbia River (Spruell and Allendorf 1997). Additional genetic work conducted in 1998 found differences between bull trout in Swift Creek Reservoir and Yale Lake indicating that bull trout in the Lewis River may exhibit spawning site fidelity similarly observed in other areas within the Columbia River Distinct Population Segment (Spruell *et al*. 1998, 1999).

Lake Merwin

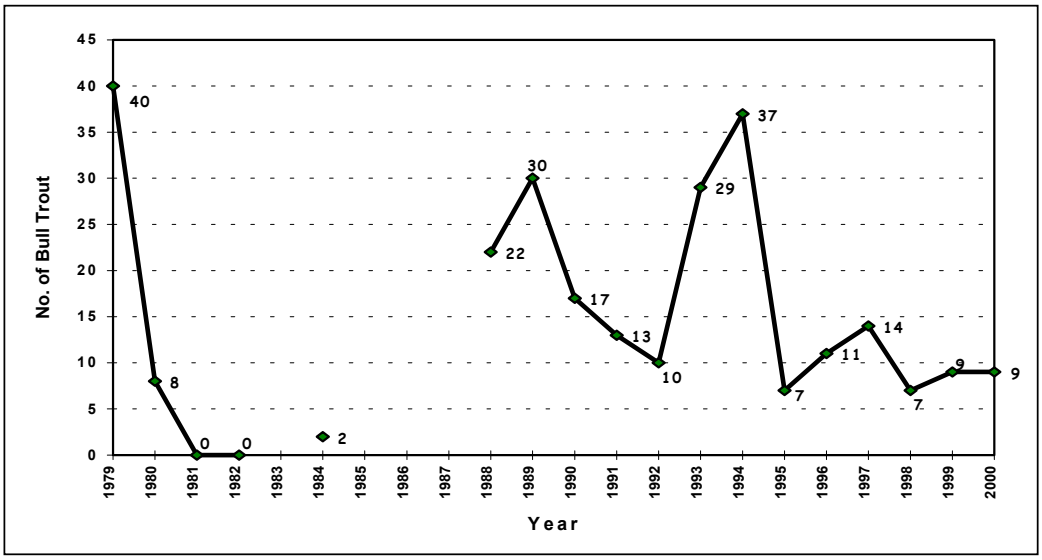
Only two verified bull trout sightings have occurred below Merwin Dam (F. Shrier, PacifiCorp, pers. comm. 2002). One adult bull trout was captured in the upstream trap at Merwin Dam, and the other entered the ladder at the Lewis River Hatchery in 1992. The origin of these bull trout is unknown and creel census and salmon related sampling efforts below Lake Merwin have not recorded any additional sightings. However, there are anecdotal reports of bull trout, or Dolly Varden, being caught in the lower Lewis River (WDF and WDG undated). Fluvial migrations of bull trout into the lower Lewis River system and the mainstem Columbia probably occurred seasonally. Additional studies are needed to determine whether or not existing bull trout in either Swift Creek Reservoir or Yale Lake would attempt this migratory pattern if connectivity were restored.

Yale Lake

The only documented spawning population of bull trout in Yale Lake is in Cougar Creek (WDFW 1998). Bull trout have been observed during annual kokanee spawning surveys in Cougar Creek since 1979. The estimated Cougar Creek spawner population ranges from 0 to 40 individuals (Figure 6). Spawning adfluvial bull trout in Yale Lake migrate into Cougar Creek from the middle of August through early September. Spawning in Cougar Creek occurs from late September through early October (Graves 1983, PacifiCorp 2000b, 2001, 2002). The fall 2001 count of bull trout spawners in Cougar Creek was 9 adults.

Swift Creek Reservoir

Figure 6. Estimated spawning population of bull trout in Cougar Creek 1979-2000 (Data provided by PacifiCorp).



In addition to the survey work conducted in Cougar Creek, the U.S. Forest Service, Washington Department of Fish and Wildlife, and PacifiCorp have been collecting distribution and abundance information on bull trout in Swift Creek Reservoir since the late 1980's. Bull trout collected at the head of Swift Creek Reservoir have been marked with floy anchor tags every spring since 1989 to facilitate "mark and recapture" counts in Rush and Pine creeks (the

primary spawning tributaries for the Swift bull trout population) (Faler and Bair 1991, PacifiCorp 2000b, 2001). Between 1994 and 2000, the annual spawner population in Swift Creek Reservoir has ranged from 101 to 437 fish (Figure 7) (PacifiCorp 2000b, 2001). The 2001 bull trout population in Swift Creek Reservoir was 542 adults (PacifiCorp 2002).

In the spring of 2001, Washington Department of Fish and Wildlife operated a screw trap in the Lewis River just above Swift Creek Reservoir. Juvenile bull trout caught in the trap ranged is size from 120 millimeters to just over 200 millimeters (PacifiCorp 2002).

White Salmon River Core Habitat

Sightings of bull trout in the White Salmon River are rare. Two sightings have been reported above Condit Dam, both by Washington Department of Fish and Wildlife biologists (WDFW 1998). One fish measuring 273 millimeters (10.7 inches) was captured in a gill net set in 1986 in Northwestern Lake (WDFW 1998, USFS 1998). The second fish sampled was approximately 305 millimeters (12 inches) in length and was checked in the opening day creel census in April 1989.

In 1993, the U. S. Forest Service, in conjunction with the Washington Department of Fish and Wildlife conducted bull trout surveys in the upper White Salmon River. Survey areas were targeted based on habitat characteristics which would most likely support bull trout (USFS 1998). No bull trout were sampled during this effort. Gill net sets and creel censuses in Northwestern Lake have been conducted for many years without recording any bull trout catch (WDFW 1998). Similarly, recent fish survey work have not documented bull trout in the mainstem White Salmon, or tributaries above Northwestern Lake (WDFW 1998, 2000a, 2001a).

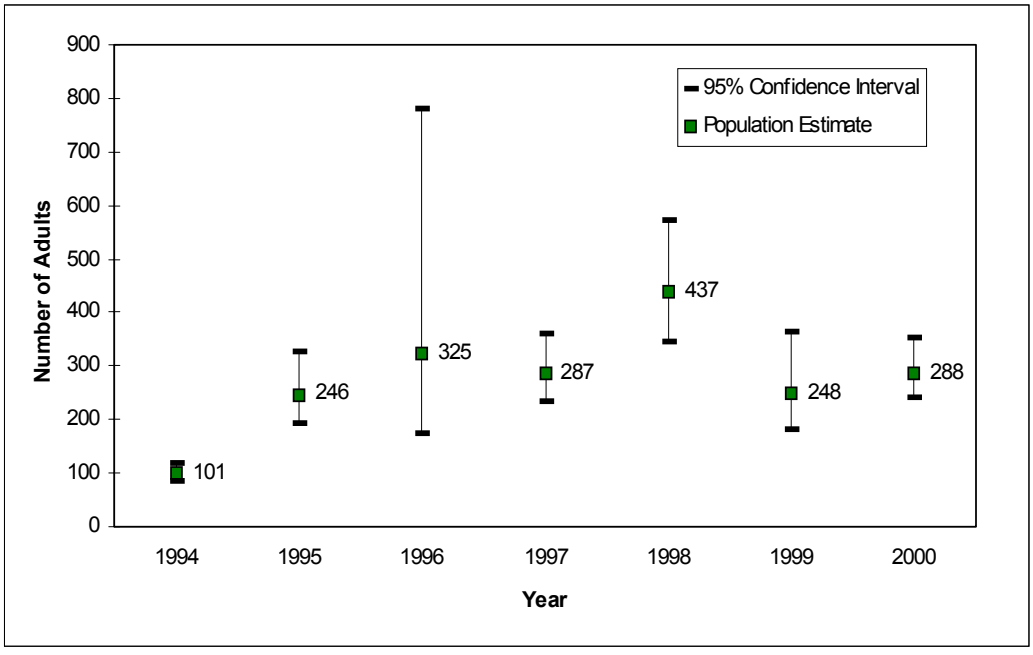
Two bull trout have been reported by sport anglers below Condit Dam in the last several years (WDFW 1998). Adult bull trout caught in the White Salmon River below Condit Dam are most likely fish that strayed in from the

Hood River in Oregon (WDFW 1998). The Hood River contains a population of bull trout which are monitored with an adult trap at the lower end of the river by the Oregon Department of Fish and Wildlife (ODFW 1997).

Klickitat Core Area

The Washington Department of Fish and Wildlife characterizes the status of bull trout in the Klickitat River as unknown (WDFW 1998). Based on recent surveys, bull trout are known to occur in the West Fork Klickitat River (WDFW 2000a, 2001a). Tributaries within the West Fork which currently support bull trout include Trappers Creek, Clearwater Creek, Two Lakes Stream, Little Muddy Creek, and an unnamed tributary to Fish Lake Stream (Figure 6).

Figure 7. Population estimates for bull trout in Swift Creek Reservoir including Pine and Rush creeks 1994 to 2000 (PacifiCorp 2001).



In the early 1990's, a single bull trout, approximately 36 centimeters (14 inches) in length was caught near the town Klickitat (WDFW 2000a). Bull trout

have been observed in the mainstem above the West Fork and in Trappers Creek (a tributary of the West Fork) during snorkel and electrofishing surveys in 1990 and 1995 (WDFW 1998). Four bull trout up to 25 centimeters (10 inches) in length were observed during snorkel surveys in the upper mainstem at River kilometer 103 (River Mile 64, above the West Fork), and 23 bull trout ranging in length from 8 to 18 centimeters (3 to 7 inches) were observed during electrofishing surveys in Trappers Creek (WDFW 2000a). Surveys in 2001 did not find bull trout in Klickitat mainstem above West Fork confluence (WDFW 2001a). Additional surveys need to be conducted in the upper drainage to determine the distribution and abundance of bull trout.

Bull trout in the West Fork Klickitat may be restricted to a resident life history form. In 2001, the Washington Department of Fish and Wildlife installed a rotary screw trap in the West Fork Klickitat River in an attempt to sample migratory juvenile bull trout (WDFW 2001a). While brook and rainbow trout were caught in the trap, no bull trout were sampled. Sampling effort during this study was limited, and extending the time frame for sampling within the West Fork Klickitat River would assist in identifying if fluvial bull trout exist in the systems. Fin clips were taken from bull trout sampled in the West Fork Klickitat during the 2001 season and genetic analysis are pending.

The Washington Department of Fish and Wildlife has identified several tributaries within the Klickitat system which provide basic cold water habitat conditions necessary for bull trout (WDFW 2000a). These streams include: Bird Creek, Hellroaring Creek, Big Muddy Creek, West Fork Klickitat River (Little Muddy Creek and Fish Lake Stream), Trappers Creek, Clearwater Creek, Crawford Creek, McCreedy Creek, Piscoe Creek, and Diamond Fork Creek. Further studies are needed to determine if these streams could support local populations of bull trout.

Columbia River

Fluvial bull trout in the Lower Columbia Recovery Unit, could have migrated seasonally from tributaries downstream into the Columbia River to

overwinter and feed. Fluvial bull trout in other Columbia River tributaries (*e.g.*, Hood and Wenatchee rivers) are known to migrate downstream as part of their normal life history strategies (ODFW 1997, Kelly-Ringel and De La Vergne 2001, Kreiter 2001). Recently, bull trout have been found in Drano Lake (most likely Hood River origin), and at the mouth of the Klickitat River (WDFW 1998, Wachtel, *in litt.* 2000). Five adult bull trout have recently (1994 to 1998) been caught in the northern pikeminnow fishery (*Ptychocheilus oregonensis*) conducted by the Washington Department of Fish and Wildlife in Bonneville Pool and in the mainstem Columbia River below Bonneville Dam (Wachtel *in litt.* 2000). Older records have documented bull trout or Dolly Varden at Bonneville Dam, and in the lower Columbia River near Jones Beach (Bonneville Fishway Report *in litt.* 1947; Catch Card Records *in litt*. 1966-1981). Moreover, historic records also indicate that Dolly Varden (bull trout) were caught in fishwheels operated on the mainstem Columbia in the late 1800's (Donaldson and Cramer 1971).

REASONS FOR DECLINE

Dams

Dams can affect bull trout by altering habitats; flow, sediment, and temperature regimes; migration corridors; and interspecific interactions, especially between bull trout and introduced species (WDW 1992; Craig and Wissmar 1993; Rieman and McIntyre 1993; T. Bodurtha, *in litt.* 1995). In addition, hydroelectric facilities can directly impact bull trout via entrainment, and by direct injury or mortality by passing through turbines. Impassable dams have caused declines of bull trout primarily by preventing access of migratory fish to spawning and rearing areas in headwaters and precluding recolonization of areas where bull trout have been extirpated (Rieman and McIntyre 1993, MBTSG 1998). In the Lower Columbia Recovery Unit, dams have fragmented bull trout habitat, isolated local populations, and prevented access to historic foraging and overwintering habitat.

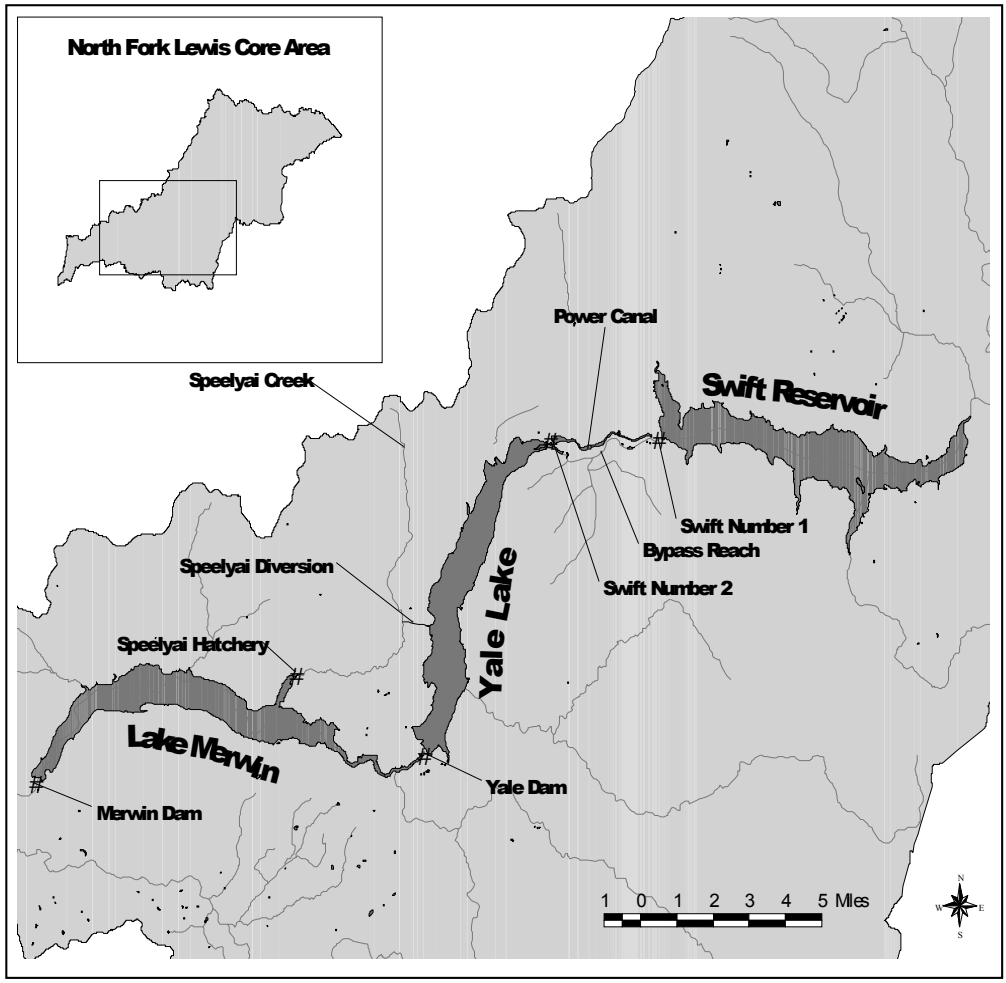
Lewis Core Area

Merwin Dam

Merwin Dam is a 136 megawatt plant located on the Lewis River approximately 32 kilometers (20 miles) upstream from its confluence with the Columbia River (Figure 8) (PacifiCorp 2000a). The reservoir formed by Merwin Dam is about 23 kilometers (14.5 miles) long with a surface area of approximately 1,620 hectares (4,000 acres). At full pool, the reservoir has a gross storage capacity of approximately 98.8 million cubic meters (422,800 acre-feet).

Merwin Dam is a migration barrier to all upstream migratory species. A trapping facility at Merwin Dam on the Lewis River allows for collection and transport of adult salmon and steelhead to hatchery holding ponds. This is currently the only potential means of upstream passage. An occasional bull trout is captured at the upstream fish trap at Merwin Dam or in the ladder at the Lewis River hatchery below the dam. The last known bull trout captured at the Lewis

Figure 8. Hydroelectric facilities on the Lewis River in Washington.



River Hatchery ladder was in 1992, while the previous observation occurred at the trap at Merwin Dam (F. Shrier, pers. comm. 2002). Most of the bull trout in Lake Merwin are thought to be present as a result of water spilled over Yale Dam. No known spawning areas exist in Lake Merwin and bull trout have been observed in the Yale Dam tailrace apparently attempting to migrate upstream (F. Shrier, pers. comm. 2002).

The Merwin turbine intakes are located near the bottom of the reservoir at about 55 meters (179 feet) below the surface at full pool which may decrease

entrainment and turbine mortality. The current Merwin flow regime was established for enhancement of juvenile fall chinook rearing conditions. A scientific review of the Merwin flows and ramping rates is currently underway to insure applicability to the other listed, proposed and candidate species.

Bull trout in the Lewis River are of fluvial origin and could have migrated seasonally from upper tributaries downstream into the lower Lewis or Columbia rivers. Additional studies are needed to determine whether or not existing bull trout in either Swift Creek Reservoir or Yale Lake would attempt this migratory
pattern if connectivity were restored. Passage at Merwin Dam would allow for reestablishment of connection with the Columbia River for foraging and overwintering.

Yale Dam

The Yale Hydroelectric Project is a 134 megawatt plant located at approximately River kilometer 56 (River Mile 35) (Figure 8). Construction of the Yale Project began in 1951 and was complete by 1953 (PacifiCorp 2000a). The reservoir formed by Yale Dam is approximately 17 kilometers (10.5 miles) long with a surface area of approximately 1,539 hectares (3,800 acres). At full pool, the reservoir has a gross storage capacity of approximately 93.7 million cubic meters (401,000 acre-feet).

The Yale Hydroelectric Project also diverts water from Speelyai Creek into Yale Lake. Speelyai Creek is a small tributary to the Lewis River that flows southwesterly from its headwaters into Lake Merwin. The diversion, built in the late 1950's by PacifiCorp, is located at the confluence with Lake Merwin. All of the water from upper Speelyai Creek is diverted through a canal into Yale Lake. Natural groundwater inflow to lower Speelyai Creek feeds the lower 6.5 kilometers (4 miles) and empties into Lake Merwin. The groundwater in lower Speelyai Creek is used for operation for the Speelyai Hatchery water supply co-operated by PacifiCorp and Cowlitz County Public Utilities District. Passage problems at the hatchery diversion has been identified as a possible limiting

factor if an additional local population were to be established in Speelyai Creek (F. Shrier, pers. comm. 2001).

It is believed that most of the bull trout in the Yale Dam tailrace originated in Yale Lake (Cougar Creek) were entrained and passed downstream through the spillway (PacifiCorp 1999). Bull trout adults enter the Yale Dam tailrace every fall apparently attempting to migrate upstream. The Washington Department of Fish and Wildlife and PacifiCorp have been working cooperatively to capture these bull trout and move them upstream to Cougar Creek. All of these fish are marked with a Floy anchor tag before release into Cougar Creek. In the fall of 1997, one bull trout captured from the previous year was recaptured in the Yale Dam tailrace indicating that downstream movement had occurred. There is general agreement that the recaptured individual returned to the Yale Dam tailrace through the spillway rather than the turbine because of its size (710 millimeters or 28 inches).

Given the low numbers of observed spawners in Cougar Creek, lack of passage at Yale Dam may be a significant effect (PacifiCorp 1999). Passage options at Yale Dam are currently being considered through the Federal Energy Regulatory Commission's relicensing process, and safe passage at this facility is necessary to limit risk to the Cougar Creek local population.

Entrainment studies conducted during the Yale Dam relicensing effort indicated that approximately 780 fish per day were entrained at the facility (PacifiCorp 1999). During a 1997 hydroacoustic study on Yale Lake, the estimated size of fish entrained in the Yale Dam turbine intake was 130 millimeters (5 inches) (PacifiCorp 1999). During the 11 week study, 52,594 fish were estimated to have been entrained through the turbines. The estimated mean lengths during the entire 11 weeks ranged from 70 millimeters (2.8 inches) to 160 millimeters (6.3 inches). No fish were sampled during the entrainment study. Graves (1983) estimated that bull trout were greater than 295 millimeters (11.6 inches) by the time they entered Yale Lake.

The relatively short sampling period for this study (January 20 to April 4) needs to be extended in order to determine if any entrainment occurs during the remainder of the year. Concurrent attempts to identify species of entrained fish through reservoir trawls did not sample any bull trout. Inferences from this work are inconclusive relative to bull trout turbine entrainment and further investigation is needed to quantify the impact.

Swift Dam

The Swift Number 1 Project at River kilometer 64.5 (River Mile 40) is a 240 megawatt plant (Figure 8) (PacifiCorp 2000a). Construction of the Swift Number 1 Project began in 1956 and was completed in 1958. The reservoir formed by Swift Dam is approximately 18.5 kilometers (11.5 miles) long with a surface area of approximately 1,895 hectares (4,680 acres) at full pool. At maximum pool, the reservoir has a gross storage capacity of approximately 176.4 million cubic meters (755,000 acre-feet).

The Swift Number 2 Project is a 70 megawatt plant owned by Cowlitz Public Utilities District and operated under contract by PacifiCorp. Construction of the Swift Number 2 Project began in 1956 and was completed in 1958. The Swift Number 2 Canal begins in the tailrace of the Swift Number 1 Powerhouse. A 5.2 kilometer (3.2 mile) power canal conveys all of the water from Swift Number 1 tailrace downstream to the Swift Number 2 Powerhouse. Diversion of water from the tailrace results in a 3.2 kilometers (2 miles) bypass of the old river channel (Swift bypass). A spillway and discharge channel prevents canal flows from exceeding the Swift Number 2 hydraulic capacity and maintains the maximum level in the canal. Lack of instream flow in the Swift bypass reach may affect access to potential spawning and rearing habitat for the Yale Lake bull trout population.

On April 21, 2002, a breach in the power canal which conveys water from Swift Number 1 downstream to Swift Number 2 resulted in the discharge of approximately 513,920 cubic meters (2,200 acre-feet of water) (USFWS, *in. litt.* 2002). The breach destroyed the Swift Number 2 Powerhouse generator station, substation, and a portion of state highway 503. In addition, the breach resulted

in the spill of an estimated 83,279 liters (22,000 gallons) of dielectric oil contained in two separate transformers into Yale Lake. While five dead bull trout were found in the power canal after the breaching, the full impacts to bull trout are unknown at this time. At present, the Cowlitz County Public Utilities District is planning to repair and rebuild Swift Number 2.

Swift Number 1 and 2 prevent upstream migration of bull trout and other resident fish.[1] Although upstream migration attempts for bull trout have not been observed in the Swift Number 2 tailrace as they have at Yale Dam, in September 1999 and 2000, the Washington Department of Fish and Wildlife and PacifiCorp placed nets in the Swift Number 2 tailrace to determine if a similar situation exists. No bull trout were observed or collected in the tailrace.

Very little data is available on the entrainment issue at Swift Number 1 and Number 2. The 1999 and 2000 opening day creel reports indicate that anglers harvested several juvenile bull trout in the Swift Number 2 power canal. The Swift Number 2 power canal was gill netted by PacifiCorp and Washington Department of Fish and Wildlife in September 2000 yielding one juvenile bull trout and one adult bull trout was observed in the Swift Number 1 surge tank in July 2000. This represents a potentially adverse effect in terms of isolation within the canal and potential entrainment. As of February 2002, an entrainment study was initiated in order to determine entrainment at Swift Creek Reservoir.

Given the importance of the bull trout population in Swift Creek Reservoir, determining the impact of entrainment at Swift Number 1 is important. It is also not known whether bull trout present in the Swift Number 2 power canal are entrained through the Swift Number 2 turbine intakes and passed to Yale Lake. Graves (1983) did not report any observed stunned or injured fish in the Swift Number 2 tailrace. An experimental net and haul procedure in the Swift Number 2 tailrace in September 1999 resulted in no adult

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[1] Analysis of impacts of Swift Number 2 on bull trout assumes that the facility will be repaired and will follow past operational schedules.

bull trout captured or observed in the tailrace waters. Two bull trout were captured in the bypass reach immediately upstream of the tailrace.

White Salmon River

Condit Dam was constructed between 1912 and 1913 and since then it has been a barrier to fish trying to ascend the White Salmon River from the Columbia River (USACOE 1989). Condit Dam has altered historic habitat conditions for bull trout in the White Salmon River, including the inundation of 2.7 kilometers (1.7 miles) of historic riverine habitat, and may make other portions of the river system below the dam unsuitable for bull trout. In addition to blocking adult and juvenile passage, Condit Dam may contribute to bull trout mortality, or injury through turbine entrainment. There is currently an agreement in place to remove the dam in the year 2006. The Federal Energy Regulatory Commission is developing a revised Environmental Impact Statement to analyze the dam removal alternative. The Lower Columbia Recovery Unit Team recommends that the dam removal alternative be implemented.

Columbia River

In 2000, the U.S. Fish and Wildlife Service issued a Biological Opinion on the Effects to Listed Species from Operations of the Federal Columbia River Power System (USFWS 2000). In general, effects of the Federal Columbia River Power System included: (1) fish passage barriers and entrainment, (2) inundation of fish spawning and rearing habitat, (3) modification of the streamflow and water temperature regime, (4) dewatering of shallow water zones during power operations, (5) reduced productivity in reservoirs, (6) gas supersaturation of waters downstream of dams, (7) loss of native riparian habitats, (8) water level fluctuations interfering with establishment of riparian vegetation along reaches affected by power peaking operations, and (9) establishment of nonnative riparian vegetation along affected reaches. Recent information indicates that adult bull trout do use the mainstem Columbia River for foraging, overwintering, as well as a migrational corridor. The operation of

Bonneville Dam and the potential impacts to bull trout in the Lower Columbia Recovery Unit is considered a research need.

Summary

Lack of passage at hydroelectric facilities within the Lower Columbia Recovery Unit has fragmented bull trout populations and prevented migration into the lower Lewis and Columbia rivers. By adopting an adfluvial life history, bull trout persist at relatively low numbers in the Lewis Core Area. The Lower Columbia Recovery Team considers upstream and downstream passage at Yale Lake and Swift Creek Reservoir to be essential for recovery. An additional concern is the low instream flow levels in the Swift bypass reach which may affect potential spawning and rearing habitat for the Yale Lake bull trout population. Additional entrainment studies are necessary to evaluate the impacts of current operations at Yale and Swift (Number 1 and 2) dams on bull trout. Once quantified, corrective actions, if necessary need to be implemented to reduce impacts to bull trout. Upstream passage for salmon at Merwin Dam currently exists in the form of trap and haul. Studies designed to assess whether or not bull trout from the upper watershed would benefit from volitional or trap and haul passage at Merwin Dam need to be conducted.

The lack of passage at Condit Dam prevents fluvial bull trout migrations between the White Salmon River and the mainstem Columbia River. The status of bull trout in the White Salmon basin is unknown. Lack of passage at Condit Dam has relegated remaining bull trout in the system to a resident life history strategy. If extant, bull trout in the White Salmon most likely persist at very low numbers in isolated groups. Removal of Condit Dam, and restoring the fluvial life history form in the White Salmon River, is considered necessary for recovery of bull trout within the Lower Columbia Recovery Unit.

Forest Management Practices

Forest management activities, including timber extraction and road construction, affect stream habitats by altering recruitment of large woody

debris, erosion and sedimentation rates, runoff patterns, the magnitude of peak and low flows, water temperature, and annual water yield (Furniss *et al.* 1991, Wissmar *et al.* 1994, Goetz 1989, Pratt 1992). Activities that promote excessive substrate movement reduce bull trout production by increasing egg and juvenile mortality, and reduce or eliminate habitat important to later life-history stages, (*e.g.*, pools filled with substrate) (Fraley and Shepard 1989, Brown 1992). The length and timing of bull trout egg incubation and juvenile development (typically more than 200 days during winter and spring) and the strong association of juvenile fish with stream substrate make bull trout vulnerable to changes in peak flows and timing
that affect channels and substrate (Goetz 1989, Pratt 1992, McPhail and Baxter 1996, MBTSG 1998).

Roads constructed throughout watersheds for forest management are a prevalent feature on managed forested and rangeland landscapes. Roads have the potential to adversely affect several habitat features (*e.g.*, water temperature, substrate composition and stability, sediment delivery, habitat complexity, and connectivity) (Baxter *et al.* 1999, Trombulak and Frissell 2000). Roads may also isolate streams from riparian areas, causing a loss in floodplain and riparian function. The aquatic assessment portion of the Interior Columbia Basin Ecosystem Management Project provided a detailed analysis of the relationship between road densities and bull trout status and distribution (Quigley and Arbelbide 1997). The assessment found that bull trout are less likely to use streams for spawning and rearing in highly roaded areas, and were typically absent at mean road densities above 1.1 kilometer per square kilometer (1.7 mile per square mile).

Lewis Core Area

Forest management practices in the Lewis River basin have combined to alter flow regimes, riparian conditions and instream habitat. As part of the Lower Lewis River Watershed Analysis, the U.S. Forest Service conducted a peak flow analysis for a number of basins in the watershed and estimated changes in stream flow associated with vegetation removal (USFS 1996).

Impacts from vegetation removal can be manifested in a number ways, including alterations in sediment and large woody debris storage and structure in channels, modifying channel characteristics by increasing streambank and streambed erosion, and modification of normal sediment supply (Chamberlin *et al.* 1991, Hauer *et al.* 1999).

The U.S. Forest Service estimated that the potential increased peak flows for the lower Pine Creek basin to be between 12 percent to 22 percent (USFS 1995). Potential increased peak flows in the middle Pine Creek basin were between 10 percent and 17 percent (USFS 1995). Timber harvesting within the Rush Creek and Cougar Creek basins has not increased the potential peak flows over 10 percent (USFS 1995, 1996).

According to the Lower Lewis River Watershed Analysis approximately 31 percent of National Forest lands within the area have been harvested since about 1940 (USFS 1996). A much higher proportion of adjoining private lands owned by A and E Forest of Lewis River and the Olympic Resources Group have also been harvested. For the watershed analysis, Pine Creek was subdivided into three basins (USFS 1996). The analysis calculated that timber harvest had occurred on approximately 36 percent of riparian reserves in the upper basin, 77 percent of the riparian reserves in the middle basin, and 23 percent of the riparian reserves in the lower basin (USFS 1996). Overall harvest rates for the upper, middle, and lower portions of the Pine Creek watershed were 75 percent, 69 percent, and 52 percent, respectively (USFS 1996). In the lower portion of Cougar Creek, only 7 percent of basin has been harvested. In contrast, the upper portion of Cougar Creek has experienced a harvest rate of 50 percent. A large proportion of the upper Cougar Creek basin is private property (USFS 1996).

A similar Watershed Analysis conducted on the Middle Lewis River calculated 28 percent of the entire area had been harvested since 1950. As part of the analysis, Rush Creek was divided into upper and lower basins. In the upper portion of Rush Creek, 23 percent of the entire upper Rush Creek basin, and 13 percent of the riparian reserves have been harvested. In the lower Rush

Creek basin, a higher proportion (49 percent of the entire basin and 23 percent of the riparian reserves) has been harvested (USFS 1995).

Large woody debris surveys conducted by the U.S. Forest Service indicated the Rush Creek is characterized as having "good" quantities of large woody debris (greater than 80 pieces of large woody debris per mile) (USFS 1995). In contrast, large woody debris concentrations in Pine Creek were considered "poor" (less than 40 pieces per mile), and that the potential for future recruitment was low having been affected by either past logging practices, or the eruption of Mt. St. Helens (USFS 1995). No estimates for Cougar Creek were conducted since most of the watershed is not contained within the National Forest boundary.

The average road density between the upper portions of Yale Lake to Pine Creek (Lower Lewis River Watershed Analysis) were calculated at 2.1 kilometers per square kilometer (3.41 miles per square mile) (USFS 1995). The lower portion of Pine Creek had the highest road densities within the Lower Lewis River area at 4.0 kilometers per square kilometer (6.44 miles per square mile). In addition, the lower portions of Pine Creek contained a high number of stream crossings per mile which contributes to habitat fragmentation (USFS 1995). Compounding the problems associated with elevated sediment loads from high road densities, are the impacts of past timber harvests and mudflows subsequent to the eruption of Mt. St. Helens which have also contributed additional inputs of fine sediment to the stream (USFS 1995).

Road densities within the Cougar Creek watershed are lower than the densities within Pine Creek. The upper Cougar Creek basin has the higher road density with 2.2 kilometers per square kilometer (3.51 miles per square mile), while the lower Cougar Creek basin has only 1.1 kilometer per square kilometer (1.82 miles per square mile) (USFS 1995).

The road density for the area from above Pine Creek to just above Alec Creek (Middle Lewis River Watershed) is 1.6 kilometer per square kilometer (2.57 miles per square mile). However, the road density in the lower Rush Creek

basin is 2.3 kilometer per square kilometer (3.7 miles per square mile), which represents potentially excessive fine sediment inputs to the system. The road density in the upper Rush Creek basin is only 0.4 kilometers per square kilometer (0.7 miles per square mile). Flood events in the 1970's sent large pulses of sediment into Rush Creek increasing the average channel width 38 percent (USFS 1996). The stream has adjusted to these sediment pulses over time by channel narrowing and/or downcutting.

High road densities within or upstream from sensitive bull trout local populations need to be reduced. Of specific concern are upper Cougar Creek, Pine Creek, and lower Rush Creek. Decreasing sediment input and peak flow events (Pine Creek) in these important spawning and rearing areas will assist in maintaining these important local populations.

Klickitat Core Area

The Yakama Nation has a timber harvest program occurring on reservation land. Any direct, or indirect impacts similar to those described for the Lewis are unknown. Coordination with the Yakama Nation is needed to investigate possible impacts to bull trout habitat.

Within the Klickitat River, sedimentation and turbidity are viewed as a significant factor limiting habitat productivity in the watershed. However, the primary source of this sediment is naturally generated glacial silt from the eastern flanks of Mount Adams, which is delivered to the mainstem Klickitat by snowmelt runoff via Big Muddy and Little Muddy creeks. Additional sources of excess sediment probably occur at a more localized scale (WSCC 2001). To date, there has been no complete inventory of sediment sources and potential impacts to bull trout within the basin. Increased sediment loads associated with logging roads near tributary streams has been identified as a potential problem withing various locations within the basin (WSCC 2001). A complete watershed scale evaluation of sediment sources and impacts to bull trout habitat is needed.

White Salmon River

A watershed analysis conducted by the U.S. Forest Service in the upper White Salmon River indicated that based on past management activities, portions of the upper White Salmon River may be subject to increased peak flow events (USFS 1998). Both timber harvest and fires have impacted U.S. Forest Service lands. Currently, 61 percent of U.S. Forest Service lands are in either late-successional or old growth status (USFS 1998). Seventy-two percent of riparian areas within the upper White Salmon are considered to be late-successional, as compared with 38 percent for the entire basin. Impacts from forest management practices on bull trout within the White Salmon River need further investigation after local populations are identified.

Road densities in the upper, middle, and lower White Salmon River were calculated to be 2.3 kilometers per square kilometer (3.7 miles per square mile), 1.9 kilometers per square kilometer (3.1 miles per square mile), and 2.5 kilometers per square kilometer (4.0 miles per square mile), respectively. Tributary road density in the upper White Salmon ranged from 0.1 to 2.7 kilometers per square kilometer (0.2 to 4.4 miles per square mile). While road densities in the White Salmon River exceed recommended levels (Quigley and Arbelbide 1997) for bull trout, specific actions targeting areas for road decommissioning is contingent on identification of local population within the watershed and bull trout specific limiting factors analysis.

Summary

Restoration activities designed to improve channel stability and function should be implemented in appropriate areas within or adjacent to bull trout local populations in the Lewis River. Corrective actions should include, but are not limited to, reduction in instream and bank erosion, increasing the quantity of large woody debris (and opportunity for recruitment), and normalizing sediment input and peak flow events which impact Pine, Rush, and Cougar Creeks. In addition, the Lower Columbia Recovery Team has identified coordination with private land holders (A and E Forest of Lewis River and Olympic Resources

Group) in the upper Pine Creek as necessary to identify habitat problems and to recommend restoration actions. Increased coordination with the Yakama Nation is needed to assess impact of forest management activities on bull trout local populations in the Klickitat River. Subsequent to identification of bull trout local populations in the White Salmon, forest management activities and possible impacts to bull trout need to be identified.

Road densities in portions of the Lewis River exceed desirable levels and contribute to degraded habitat conditions. Road densities in areas which are directly or indirectly (affects from upstream sources) impact local populations of bull trout in Pine, Rush, and Cougar creeks need to be reduced. Subsequent to identification of local populations, a thorough watershed evaluation of impacts from roads needs to be conducted in both the White Salmon and Klickitat rivers.

Livestock Grazing

Klickitat Core Area

Improperly managed livestock grazing degrades bull trout habitat by removing riparian vegetation, destabilizing streambanks, widening stream channels, promoting incised channels and lowering water tables, reducing pool frequency, increasing soil erosion, and altering water quality (Howell and Buchanan 1992, Mullan *et al.* 1992). These effects reduce overhead cover, increase summer water temperatures, promote formation of anchor ice in winter, and increase sediment in spawning and rearing habitats. Some cattle grazing occurs within the Klickitat River basin and has resulted in eroded stream banks, increased sedimentation, and incised stream channels. A complete survey identifying problem areas is needed in the basin.

No information is currently available on impacts of livestock grazing in the other areas of the Lower Columbia Recovery Unit.

Agricultural Practices

Klickitat Core Area

Warm water temperatures due to natural low flows within the Klickitat drainage may be a concern for adult bull trout that may spawn in the mainstem or in the lower reaches of tributaries as well as for juveniles that may rear in the area (WSCC 2001). Limited flow regulation occurs within the Klickitat watershed, with the exception of portions of Outlet Creek, Hellroaring Creek, Swale Creek, and the Little Klickitat River, where diversions for water supply and irrigation occur. An instream flow study conducted in 1991 identified Swale Creek and the Little Klickitat River and a number if its tributaries as having insufficient flows to support anadromous and resident fish populations (WSCC 2001). Both these streams have been placed on the State "water quality impaired" (303d) list for instream flows (http://www.ecy.wa.gov/programs/wq/303d/index.html).

Water temperatures in excess of State standards have been identified as water quality problems in Butler Creek, Swale Creek, and the Little Klickitat River. Temperatures exceeding State water quality standards have been recorded in these streams primarily during low flow periods during the summer months and it is assumed that these problems are at least in part due to lack of stream shading due to degraded or nonexistent riparian areas and low summer flows (WSCC 2001).

Given the available information, it is unclear which tributary streams within the Klickitat River, that could have historically sustained bull trout are currently being impacted by agricultural practices. After specific areas for local populations of bull trout have been identified, reintroduction efforts need to be coordinated with a specific bull trout limiting factors analysis to prioritize restoration activities. Cooperation and coordination with private landowners is essential in the process of identifying the locations of specific actions needed.

No information is currently available on impacts of agricultural practices in the other areas of the Lower Columbia Recovery Unit.

Transportation Network

No specific information on the impact of transportation networks on bull trout was available during the preparation of this draft.

Mining

No specific information on the impact of mining on bull trout was available during the preparation of this draft.

Residential Development and Urbanization

No specific information on the impact of residential development and urbanization was available during the preparation of this draft.

Fisheries Management

Hatchery Production

Since the construction of the dams on the Lewis and White Salmon rivers, passage for anadromous fish has been blocked, and historic nutrient input provided by post-spawn salmon and steelhead has not occurred. This could represent a major limiting factor to fish production within the Lewis and White Salmon rivers. An assessment of nutrient levels and cycling would provide important information for any reintroduction efforts above the dams.

Hatchery production within the basin is funded by PacifiCorp under an agreement with the Washington Department of Fish and Wildlife. Three hatcheries are located on the Lewis River, two below Merwin Dam, and one on the north shore of Lake Merwin. Species currently stocked below Swift Creek Reservoir include spring chinook, coho, steelhead, cutthroat trout, rainbow trout, and tiger musky.

The nonnative tiger musky program was instituted in Merwin's Speelyai Bay in an attempt to control northern pikeminnow. While predation by other

nonnative species like northern pike (*Esox lucius*), lake trout *(S. namaycush)*, and largemouth bass (*Micropterus salmoides*) on juvenile bull trout is known to occur, the extent to which tiger musky might prey on bull trout is unknown (Donald and Alger 1993, MBTSG 1996a, Fredenberg 2000, MBTSG 1996b, WDFW 1998, Schmetterling 2001). Given the extremely low numbers of bull trout in Lake Merwin, and the uncertainty of niche overlap if bull trout were present, tiger musky are not currently considered a threat to the remaining bull trout in the Lewis Core Area. However, the Lower Columbia Recovery Team has identified Speelyai Creek as a possible reintroduction site for a bull trout local population. While several other issues within Speelyai Creek must be addressed (*e.g.*, passage barriers and low flow conditions) in order for reintroduction to proceed, the possible interaction and predation of tiger musky on bull trout needs investigation.

In addition, kokanee and rainbow trout are planted upstream of Merwin Dam. The Lewis River above Swift Creek Reservoir is not currently planted with hatchery fish. Kokanee were introduced into the upper reservoirs in the late-1950's and early-1960's and now spawn in tributaries of Lake Merwin and Yale Lake. In the absence of a historic connection within the Columbia River, and the current lack of native anadromous fish production within the basin, introduction of rainbow trout and kokanee probably has benefitted large adult bull trout by providing supplemental forage (Faler and Bair 1991, Pratt 1992).

Nonnative brook trout present an ongoing threat to bull trout within the portions of the recovery unit. Brook trout were stocked in upper Lewis watershed, and are still present in Rush Creek above the falls at River kilometer 2.7 (River Mile 1.7), and some tributaries to Pine Creek. Brook trout are also known to occur in portions of the White Salmon and Klickitat rivers (WDFW 2000a; 2001a). Introduced brook trout threaten bull trout through hybridization, competition, and possibly predation (Leary *et al.* 1993, Thomas 1992, WDW 1992, Rieman and McIntyre 1993, MBTSG 1996a). Hybridization between brook trout and bull trout has been previously reported in Washington (WDFW 1998). Hybridization results in offspring that are frequently sterile (Leary *et al.* 1993), although recent genetics work has shown that reproduction by hybrid fish is occurring at a higher level than previously suspected (Kanda 1998). Brook trout mature at an earlier age and have

a higher reproductive rate than bull trout. This difference may favor brook trout over bull trout when they occur together, often leading to replacement of bull trout with brook trout (Leary *et al.* 1993, MBTSG 1995). The magnitude of threats from nonnative fishes is highest for resident bull trout because they are typically isolated and exist in low abundance.

Hatchery rainbow trout have been stocked in the Little Klickitat River and tributaries at least since the late 1960's. Nonnative brown trout were also stocked in the Little Klickitat River in 1984 and 1985. It is difficult to tell what impacts stocking may have had on bull trout without historical distribution and abundance of bull trout in the drainage. However, brown trout have been introduced and are established in several areas within the Columbia River Distinct Population Segment and likely compete for food and space and prey on bull trout (Ratliff and Howell 1992, Pratt and Huston 1993). In the Klamath River basin for example, brown trout occur with bull trout in three streams and have been observed preying on bull trout in one (Light *et al.* 1996). Brown trout may compete for spawning and rearing areas and superimpose redds on bull trout redds (Pratt and Huston 1993, Light *et al.* 1996, MBTSG 1996a). Specific interactions within the basin between hatchery origin fish (both native and nonnative) and bull trout have not been investigated in the Lower Columbia Recovery Unit.

Harvest

The harvest of bull trout has been prohibited in the Lower Columbia Recovery Unit since 1992. Bait fishing is legal in some areas and may result in some level of hooking mortality. Historical catch of bull trout in the recreational fisheries has been recognized as a possible factor in contributing to the decline of bull trout in stocks within the recovery unit. In a 1999 creel census survey, seven bull trout were caught in the fishery in the Swift Power Canal (WDFW 2001b). Of more concern is that only 38 percent of the anglers questioned correctly identified bull trout. A more intensive angler education program is needed to protect bull trout.

There has been some indirect hooking mortality from catch and release of bull trout in the Lewis River. A resident kokanee/rainbow trout sport fishery takes place in Lake Merwin. There is a popular kokanee fishery in Yale Lake. Incidental catch of bull trout in both reservoirs is thought to be low. A very popular sport fishery for hatchery rainbow trout takes place in Swift Creek Reservoir. The river above Swift Creek Reservoir is a catch and release no-bait area up to the lower falls, (the upper limit of adfluvial bull trout). Specific areas of concern for possible bull trout poaching is the area below Eagle Cliff Bridge. Increased enforcement of bull trout fishing regulations in this area is needed. In addition, current fishing regulations in this area should be reviewed and modified if necessary in order to protect bull trout. In an effort to address potential poaching concerns, old spur roads, which allow access to the Lewis River above Swift Creek Reservoir should be identified and closed where appropriate.

General trout fishing seasons have remained the same in the Klickitat River for approximately 10 years. In the Klickitat River, bull trout were included as part of the two trout catch limit, with a minimum size of 31 centimeters (12 inches). In the Little Klickitat River regulations were more liberal, with an eight trout catch limit (changed to five trout in 1994) with no minimum size. Fishing was prohibited in the upper Klickitat River and tributaries within the boundaries of the Yakama Indian Reservation. With the exception of one 432 millimeters (17 inches) bull trout caught in 1991 downstream from the Little Klickitat River (WDFW 1998) there are no records or references to the catch of bull trout. Although angling impacts and harvest are not known, they may have been significant prior to the implementation of restrictive fishing regulations in the early 1980's.

Summary

Within areas of the Lower Columbia Recovery Unit, brook trout pose a threat to bull trout through hybridization and possible competition for food and space. Actions should be taken to reduce brook trout numbers in the Lewis, Klickitat, and White Salmon rivers where local populations of bull trout overlap with brook trout. Interactions between bull trout and other nonnative species (*e.g.*, brown trout and

tiger musky) need further investigation and when indicated, appropriate actions should be implemented to reduce impacts. Incidental or illegal take of bull trout in the Lewis River is of concern. Increased enforcement and assessment of "take" levels needs to be quantified. Angler education programs should be enacted to reduce the incidental "take" of bull trout in the Lewis River. If needed, modification of fishing regulations should be implemented in order to protect sensitive bull trout populations (*e.g.*, Swift Creek Reservoir). An assessment of nutrient levels and cycling should be conducted to determine impacts from the loss of anadromous salmon and steelhead production within the recovery unit.

Isolation and Habitat Fragmentation

Numerous road culverts throughout the Klickitat watershed have been identified as actual or potential barriers for fish movement and migration. The Washington State Department of Transportation has identified 11 culverts as barriers in their survey of State highways (WSCC 2001). No specific information on culvert barriers was available on the White Salmon River. Until local populations in both watersheds are identified and a comprehensive culvert study is conducted, specific recommendations for restoration actions can not be made.

Construction and operation of dams has contributed to habitat fragmentation and isolation of bull trout local populations. For example, Merwin Dam, and Swift dams Number 1 and 2 are barriers to upstream migrants. Yale Dam also lacks sufficient passage, and the hatchery diversion has been identified as a limiting factor should a local population be established in Speelyai Creek (F. Shrier, pers. comm. 2001).

ONGOING RECOVERY UNIT CONSERVATION MEASURES

Bull trout have been observed in the Yale Dam tailrace and, for the last 4 years during the fall migration, have been actively collected and transported upstream. Given the low abundance in Cougar Creek, loss of any individuals via entrainment at Yale Dam is important. The Washington Department of Fish and Wildlife and PacifiCorp will continue to sample the Yale tailrace and transfer fish to Yale Lake. The net effect of transporting adult bull trout upstream to Yale Lake will be beneficial in terms of increasing the spawning population pool in the interim until passage issues are resolved for the entire basin.

PacifiCorp proposes to evaluate and potentially implement a strobe light system in an effort to prevent bull trout entrainment at the Yale Dam and Swift Number 1 spill and turbine intakes. Ultimately, long-term usage of strobes as a means of addressing entrainment issues will require the approval of the resource agencies. However, PacifiCorp believes that available scientific information suggests that strobes may prove successful in substantially reducing salmonid entrainment at the projects. In terms of the Yale Dam spillway, PacifiCorp proposes to initiate an engineering study to address modification of the spillway configuration in order to reduce any potential for fish injury or mortality.

For spawning and rearing habitat protection, action is needed to protect the existing habitat around Cougar Creek. To protect spawning and rearing habitat in the Lewis River, PacifiCorp has purchased Weyerhaeuser Corporation holdings on the north side of Cougar Creek with the express purpose of establishing a conservation easement on the riparian corridor of this area in perpetuity for bull trout spawning and rearing habitat protection. The easement will include a 152 meter (500 foot) strip on either side of Cougar Creek and a 61 meter (200 foot) strip on either side of Panamaker Creek. This easement will be treated as a “no-touch” zone to provide a high level of certainty that long-term benefits will accrue for bull trout, cutthroat trout and other aquatic species.

In addition, PacifiCorp and Cowlitz Public Utilities District have purchased lands from Weyerhaeuser Corporation on the east side of the Swift Creek arm

(Devil's Backbone) for protection of shoreline rearing habitat and with the intent of placing a conservation easement along that adjacent riparian zone for the protection of that habitat in perpetuity. This conservation easement will result in increased protection for the adjacent riparian zone.

One of the objectives for riparian protection contained in the U.S. Fish and Wildlife Service conservation guidance document (USFWS 1998b) states that the goal of riparian management should be to reestablish historical vegetative patterns, disturbance regimes, species composition, and successional stages. Currently, PacifiCorp manages its lands surrounding Lake Merwin to meet the objectives of the Merwin Wildlife Management Plan (PacifiCorp 1998). Those objectives work well to meet the intent of recommendations from the U.S. Fish and Wildlife Service conservation guidance for bull trout including promoting road closure or limited access controls, and self-imposed standards that exceed riparian protection requirements of Washington State Forest Practice standards.

PacifiCorp has implemented modifications to Yale Dam turbine operations to reduce total dissolved gas levels in the Yale Dam tailrace. Temperature fluctuation in the Yale Dam tailrace is currently being addressed. PacifiCorp is studying temperatures and total dissolved gases in the Swift Number 1 and 2 tailraces. This may lead to potential equipment modification, subject to U.S. Fish and Wildlife Service approval, that will reduce total dissolved gases and temperature effects while providing for continued operational flexibility.

PacifiCorp has been funding and cooperating in a joint Washington Department of Fish and Wildlife and U.S. Forest Service bull trout population monitoring project in Swift Creek Reservoir since 1988. Currently, Washington Department of Fish and Wildlife is utilizing a mark-revisual protocol to estimate reservoir adult spawner population size. PacifiCorp proposes to continue providing partial funding and in-kind services to maintain the Swift population monitoring database.

Washington State Forest Practices

In January 2000, the Washington Forest Practices Board adopted new emergency forest practice rules based on the Forest and Fish Report (WFPB 2000). These rules address riparian areas, roads, steep slopes, and other elements of forest practices on non Federal lands. Some provisions of forest practice rules represent improvements over previous regulations, for other provisions the plan relies on an adaptive management program for assurance that the new rules will meet the conservation needs of bull trout. Research and monitoring being conducted to address areas of uncertainty for bull trout include protocols for detection of bull trout, habitat suitability, forestry effects on groundwater, field methods or models to identify areas influenced by groundwater, and forest practices influencing cold water temperatures. The Forest and Fish Report development process relied on broad stakeholder involvement and included State agencies, counties, Tribes, forest industry and environmental groups. A similar process is also being used for agricultural communities in Washington and is known as "Agriculture, Fish and Water." The Service is considering the possible impacts and potential benefits from both of these State processes relative to bull trout recovery.

Washington State Bull Trout Management Plan

The Washington Department of Fish and Wildlife has developed a bull trout management plan that addresses both bull trout and Dolly Varden (WDFW 2000b). The Washington Department of Fish and Wildlife no longer stocks brook trout in streams or lakes connected to bull trout waters. Fishing regulations prohibit harvest of bull trout, except for a few areas where stocks are considered "healthy," within the State of Washington. The Washington Department of Fish and Wildlife is also currently involved in a mapping effort to update bull trout distribution data within the State of Washington, including all known occurrences, spawning and rearing areas, and potential habitats.

RELATIONSHIP TO OTHER CONSERVATION EFFORTS

Subbasin Planning

As part of the Pacific Northwest Electric Power Planning and Conservation Act of 1980, the Bonneville Power Administration has the responsibility to protect, mitigate and enhance fish and wildlife resources affected by operation of Federal hydroelectric projects in the Columbia River and its tributaries. The Northwest Power Planning Council developed the Columbia River Basin Fish and Wildlife Program which is implemented by the Bonneville Power Administration, U.S. Army Corps of Engineers, Bureau of Reclamation, and the Federal Energy Regulatory Commission. Coordination of Bonneville Power Administration's responsibilities for protection, enhancement, and mitigation and incorporation of recommendations by the Northwest Power Planning Council is in part done through the development of subbasin summaries which identify status of fish and wildlife resources, limiting factors, and recommended actions at the subbasin level.

In November 2000, the Draft White Salmon and Klickitat Subbasin Summaries were completed (NPPC 2000a and NPPC 2000b). More recently, the Draft Lewis River Subbasin was completed in October, 2001 (NPPC 2001). The subbasin summaries provide an overview of fish and wildlife resources, their current status, a review of watershed assessment conducted to date, and a brief description of limiting factors within the basin.

The cornerstone goal of the White Salmon Subbasin Summary is to "Restore wildlife and fish population to levels that support ecosystem benefits and harvest, restoration of the habitat on which these populations rely (restore the natural ecosystem functions of the White Salmon watershed), sustain and/or restore water quality, and maintain long-term economic and community sustainability." Strategies identified within the White Salmon summary include improving fish survival at adult and juvenile life history stages, removal of passage barriers, restoration of instream and riparian habitats, and coordination with local watershed groups. These strategies are consistent with the Lower Columbia Recovery Unit objectives for bull trout. Similarly, the Klickitat Subbasin Summary goal is to "Protect, restore, and enhance

fish and wildlife species and habitats." To achieve this goal, the Klickitat summary identifies the need to restore watershed function, and increase the information data base, while ensuring both Tribal and nontribal fishing opportunities.

The bull trout recovery plan and the Subbasin Summaries acknowledge the lack of specific information needed to implement bull trout recovery. The Lower Columbia Recovery Unit Team recommends the development of comprehensive watershed assessments to address specific bull trout needs. The Lower Columbia Recovery Unit Team will continue to coordinate with this subbasin summary process through the development of subbasin plans.

Salmon Recovery Efforts

In 1998 and 1999, the National Marine Fisheries Service listed spring chinook salmon, steelhead, and chum salmon in the lower Columbia River as threatened under the Endangered Species Act. These Evolutionary Significant Units (Lower Columbia River chinook and steelhead, and Columbia River chum) geographically overlap with the Lower Columbia Recovery Unit for bull trout. As part of the recovery planning process for chinook, steelhead, and chum the National Marine Fisheries Service has issued guidance for the technical development of recovery plans (NMFS *in litt.* 2001). The framework for steelhead and salmon recovery plan development is divided into distinct geographic areas, or domains which may contain multiple Evolutionarily Significant Units. Recovery plans for listed salmon and steelhead will contain the same basic elements as mandated by the Endangered Species Act, and include: (1) objective measurable criteria, (2) description of site-specific management actions necessary to achieve recovery, and (3) estimates of cost and time to carry out recovery actions. Currently, the National Marine Fisheries Service has organized a technical review team to deal with recovery plan development in the Lower Columbia River (including the upper Willamette River spring chinook and steelhead). Time-frames for completion of the recovery plan for the Lower Columbia and Willamette have not been finalized, but the Lower Columbia Recovery Unit Team will coordinate the implementation of bull trout recovery actions with salmon and steelhead measures to avoid duplication and maximize the use of available resources.

State of Washington

Salmon Recovery Act

The Governor's office in Washington State has developed a Statewide strategy (Washington Governor's Salmon Recovery Office 1999) that describes how State agencies and local governments will work together to address habitat, harvest, hatcheries, and hydropower as they relate to recovery of listed species. The Salmon Recovery Act, passed in 1998, provides the structure for salmonid protection and recovery at the local level (counties, cities, and watershed groups).

The Salmon Recovery Planning Act of 1998 directs the Washington State Conservation Commission, in consultation with local government and treaty Tribes to invite private, Federal, State, Tribal, and local government personnel with appropriate expertise to convene as a Technical Advisory Group. The purpose of the Technical Advisory Group is to identify habitat limiting factors for salmonids. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon, including all species of the family Salmonidae." The bill further clarifies the definition by stating "These factors are primarily fish passage barriers and degraded estuarine areas, riparian corridors, stream channels, and wetlands." It is important to note that the responsibilities given to the Conservation Commission in House Bill 2496 do not constitute a full limiting factors analysis. This report is based on a combination of existing watershed studies and knowledge of the Technical Advisory Group participants.

The Washington Department of Fish and Wildlife, salmon and steelhead inventory and assessment program, is currently updating their database to include the entire State, which consists of an inventory of stream reaches and associated habitat parameters important for the recovery of salmonid species and bull trout.

Lower Columbia Fish Recovery Board

Created by State law (RCW 77.85.200) in 1998, the Lower Columbia Fish Recovery Board oversees and coordinates salmon and steelhead recovery efforts in the Lower Columbia Salmon Recovery Region. The region encompasses the

mainstem Columbia River and over 16 tributaries from the White Salmon River downstream to Chinook River, near the mouth of the Columbia. The area is inclusive of the Washington portions of the Evolutionary Significant Units for lower Columbia River steelhead, chinook, chum, and bull trout, which are all listed as threatened, and cutthroat trout and coho salmon, which are under consideration for listing. By law, the 15 members of the Lower Columbia Fish Recovery Board include representatives from city and county government, the Legislature, the Cowlitz Tribe, the hydro-system operators, private landowners, the environmental community and concerned citizens. State law also mandates that the Lower Columbia Fish Recovery Board maintain a technical advisory committee. The 18-member committee includes technical experts from Federal and State resource agencies, local government, and the private sector.

The Lower Columbia Fish Recovery Board's goal is to restore lower Columbia salmon, steelhead, and other threatened fish stocks to healthy and harvestable levels. In keeping with its legislative charge, the Lower Columbia Fish Recovery Board focuses on habitat protection and restoration, watershed planning and recovery planning.

The Lower Columbia Fish Recovery Board is leading a collaborative regional recovery planning effort involving Federal and State agencies, Tribes and local governments. The plan will cover all fish species listed or proposed for listing under the Endangered Species Act. It will address recovery actions associated with habitat, hydroelectric power, hatcheries, and harvest and will be coordinated with watershed planning efforts. It will integrate recovery efforts by Federal and State agencies, Tribes, and local governments into comprehensive recovery program with the goal of restoring listed and depressed salmon and steelhead stocks to healthy, harvestable levels. The Lower Columbia Fish Recovery Board anticipates completion of a draft plan by early to mid-2003. The Lower Columbia Recovery Unit Team will continue to coordinate with this effort.

Biological Opinion on the Federal Columbia River Power System

On December 20, 2000, the Service issued a Biological Opinion on the "Effects to Listed Species from Operation of the Federal Columbia River Power System" (USFWS 2000). The opinion identifies the need for continued research into distribution of bull trout within the mainstem Columbia River. The Biological Opinion recognizes in all likelihood that as recovery actions are implemented (*e.g.*, passage at Condit Dam) bull trout will increase their use of the mainstem Columbia. Reasonable and prudent measures in the Biological Opinion are consistent with primary research needs identified by the Lower Columbia Recovery Unit Team. As recovery proceeds, the need for research to investigate problems associated with fish ladder use, entrainment, spill, flow attraction, and water quality will need to be addressed through the formal consultation process.

STRATEGY FOR RECOVERY

A core area represents the closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (*i.e.*, habitat that could supply all the necessary elements for the long-term security of bull trout, including for both spawning and rearing, as well as for foraging, migrating, and overwintering) and a core population (*i.e.*, bull trout inhabiting a core habitat) constitutes the basic core area upon which to gauge recovery within a recovery unit. Within a core area, many local populations may exist.

It is likely that historic distribution of bull trout was more expansive than currently observed. Current distribution of bull trout in the Lower Columbia Recovery Unit is fragmented and bull trout exist in two core areas (Lewis and Klickitat). The White Salmon River is considered core habitat and reestablishment of bull trout in the watershed is considered necessary for recovery. Migratory life-history strategies of bull trout probably used the mainstem Columbia River for feeding and overwintering. The extent and timing of use of the mainstem Columbia River by bull trout is a research need and considered as potential core habitat important for recovery of fluvial bull trout in the recovery. Isolation and fragmentation of bull trout by dams and poor habitat conditions were identified as limiting factors in the Lower Columbia Recovery Unit. Removal of these threats, and reestablishing connectivity within the basin has been deemed essential for recovery.

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range, so that the species can be delisted.** To achieve this goal the following objectives have been identified for bull trout in the Lower Columbia Recovery Unit.

- **Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Lower Columbia Recovery Unit.**
- **Maintain stable or increasing trends in abundance of bull trout.**

- **Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.**

- **Conserve genetic diversity and provide opportunity for genetic exchange.**

Rieman and McIntyre (1993) and Rieman and Allendorf (2001) evaluated the bull trout population numbers and habitat thresholds necessary for long-term viability of the species. They identified four elements, and the characteristics of those elements, to consider when evaluating the viability of bull trout populations. These four elements are 1) number of local populations; 2) adult abundance (defined as the number of spawning fish present in a core area in a given year); 3) productivity, or the reproductive rate of the population (as measured by population trend and variability); and 4) connectivity (as represented by the migratory life history form and functional habitat). For each element, the Lower Columbia Recovery Unit Team classified bull trout into relative risk categories based on the best available data and the professional judgment of the team.

The Lower Columbia Recovery Unit Team also evaluated each element under a potential recovered condition to produce recovery criteria. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. Recovery criteria for the Lower Columbia Recovery Unit reflect 1) the stated objectives for the recovery unit, 2) evaluation of each population element in both current and recovered conditions, and 3) consideration of current and recovered habitat characteristics within the recovery unit. Recovery criteria will probably be revised in the future as more detailed information on bull trout population dynamics becomes available. Given the limited information on bull trout, both the level of adult abundance and the number of local populations needed to lessen the risk of extinction should be viewed as a best estimate.

This approach to developing recovery criteria acknowledges that the status of populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas may be limited by natural attributes or by patch size and may always remain at a relatively high risk of extinction. Because of limited data

within the Lower Columbia Recovery Unit, the recovery unit team relied heavily on the professional judgment of its members.

Local Populations

Metapopulation theory is important to consider in bull trout recovery. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994) (see Chapter 1). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. In part, distribution of local populations in such a manner is an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than 5 local populations are at increased risk, core areas with between 5 and 10 local populations are at intermediate risk, and core areas with more than 10 interconnected local populations are at diminished risk. Currently, only three local populations have been identified in the Lower Columbia Recovery Unit, and bull trout are considered to be at a increased risk. Additional local populations are needed to reduce the risk from deterministic or stochastic events which may threaten bull trout.

Abundance

The recovered abundance levels in the Lower Columbia Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows us to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift (see Chapter 1). For the purpose of recovery planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes. Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the

loss of genetic variation due to genetic drift and to maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 1988). Effective population sizes required to maintain long-term genetic variation that can serve as a reservoir for future adaptations in response to natural selection and changing environmental conditions are discussed in Chapter 1 of the recovery plan.

For bull trout, Rieman and Allendorf (2001) estimated that a minimum number of 50 to 100 spawners per year is needed to minimize potential inbreeding effects within local populations. In addition, a population size of between 500 and 1,000 adults in a core area is needed to minimize the deleterious effects of genetic variation from drift.

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations containing fewer than 100 spawning adults per year were classified as at risk from inbreeding depression. Bull trout core areas containing fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Bull trout in the Lower Columbia Recovery Unit persist at low numbers in fragmented local populations. Adult population estimates for bull trout in Swift Creek Reservoir (Pine and Rush creeks combined) ranged from 101 to 542 from 1994 to 2001, respectively. The majority of spawning occurs in Rush Creek and the 8 year average for both creeks is 309 bull trout. Based on the aforementioned guidance, bull trout in Rush and Pine creeks are not at risk from inbreeding depression. Conversely, the local population in Cougar Creek is significantly below 100 individuals and is considered at risk. Overall, the Lewis Core Area is probably below 1,000 spawning adults annually and should be considered at risk from the deleterious effects of genetic drift. Bull trout in the West Fork Klickitat local population are thought to be primarily resident and low numbers indicate that this local population is at risk from inbreeding depression. If fluvial bull trout persist in the Klickitat Core Area, their abundance is most likely below 100 spawning adults, and therefore should be considered at risk from inbreeding depression. The interaction of any fluvial forms with the observed resident local population in the West Fork Klickitat is considered a

research need. Abundance of both resident and migratory bull trout in the Klickitat Core Area is likely below 1,000 spawning individuals and the core area is considered at risk from genetic drift.

Estimated abundance of bull trout among all local populations under a recovered condition in the Lower Columbia Recovery Unit is considered a research need. Uncertainty surrounding the number of local populations under a recovered condition in each core area precluded determination of the recovered abundance estimate in the Lower Columbia Recovery Unit. As more data is collected, recovered population estimates will be identified to more accurately reflect both the migratory, and resident life history components. In determining the recovered abundance, consideration of genetic risk, effective population size, and connectivity need to be incorporated with habitat productivity estimates in order to determine achievable abundance goals.

Productivity

A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself also indicate an increased risk of extinction. Therefore, the reproductive rate should indicate that the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population. A population that is below recovered abundance levels, but that is moving toward recovery, would be expected to exhibit an increasing trend in the indicator.

The population growth rate is an indicator of probability of extinction. This probability cannot be measured directly, but it can be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient for the population to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. For a population to contribute to recovery, its growth rate must indicate that the population is stable or increasing for a period of time. Given the overall lack of long-term population census information in the Lewis and Klickitat core areas, and the variability in abundance estimates for the Cougar Creek local population, bull trout in the Lower Columbia Recovery Unit were classified at increased risk.

Connectivity

The presence of the migratory life history form within the Lower Columbia Recovery Unit was used as an indicator of the functional connectivity of the system. If the migratory life form was absent from the core area, or if the migratory form is present but local populations lack connectivity, the core area was considered to be at increased risk. If the migratory life form persists in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Finally, if the migratory life form was present in all or nearly all local populations, and had the ability to connect with other local populations, the core area was considered to be at diminished risk.

Lack of passage at hydroelectric facilities within the Lower Columbia Recovery Unit has fragmented bull trout populations and prevented migration to foraging and overwintering habitat in the mainstem Columbia River. Migratory bull trout persist at low numbers within the Lower Columbia Recovery Unit by virtue of adopting an adfluvial life history in Swift Creek Reservoir and Yale Lake. Lack of passage and the low abundance of the migratory life history strategy also limits the possibility for genetic exchange and local population refounding.

Even though the migratory form persists in the Lewis River, the Lower Columbia Recovery Unit Team considered bull trout in the core area to be at an increased risk since local populations lack connectivity. Currently, bull trout in the Klickitat Core Area are most likely represented by resident forms, and consequently are also at an increased risk.

Recovery Criteria

Recovery criteria for bull trout in the Lower Columbia Recovery Unit are as follows.

1. **The recovered distribution of bull trout in the Lower Columbia Recovery Unit is unknown and considered a research need. Until additional information is obtained, at a minimum, the four existing local populations in the recovery unit need to be maintained.** Current local populations are Rush and Pine creeks (Swift Creek Reservoir) and Cougar Creek (Yale Lake) both in the Lewis Core Area, and the West Fork Klickitat River in the Klickitat Core Area. These local populations need to be maintained while studies are initiated to identify additional local populations. The establishment of additional local populations in the Lewis Core Area is essential for recovery to spread the risk of population decline or local population extirpation due to stochastic events.

   Potential local populations in the Lewis (*e.g.*, Speelyai, Rain, Ole creeks, Swift by-pass reach, and upper mainstem Lewis River) have already been identified and research should be directed at factors limiting reintroduction. While the White Salmon River is recognized as historic core habitat, and necessary for recovery, specific tributaries where local populations could occur is unknown. Similarly, additional spawning and rearing areas within the Klickitat River have not been identified. Studies in the White Salmon and Klickitat rivers should assess the potential habitat suitability and productive capacity of tributaries that could support local populations. Subsequently, factors that may limit the reintroduction potential should be identified, and corrective restoration activities or management actions should be

implemented. Reestablishment of local populations within the White Salmon and Klickitat rivers may require the use of artificial propagation which would follow current Federal policy (65 FR 56916). The Lower Columbia Recovery Team recommends that studies be initiated to determine the effectiveness and feasibility of using fish transfers and hatcheries to assist in any future reintroduction efforts. Potential local populations should be identified within 3 years and actions needed to implement reintroduction efforts will be incorporated in the review of the Lower Columbia River Recovery Unit plan.

2. **Estimated abundance of bull trout among all local populations under a recovered condition in the Lower Columbia Recovery Unit is considered a research need.** Uncertainty surrounding the number of local populations under a recovered condition in each core area precluded determination of the recovered abundance estimate in the Lower Columbia Recovery Unit. As more data is collected, recovered population estimates will be identified to more accurately reflect both the migratory, and resident life history components. In determining the recovered abundance, consideration of genetic risk, effective population size, and connectivity need to be incorporated with habitat productivity estimates in order to determine achievable abundance goals.

3. **Adult bull trout exhibit a stable or increasing trend for at least 2 generations at or above the recovered abundance level within core areas.** The development of a standardized monitoring and evaluation program which would accurately describe trends in bull trout abundance is identified as a priority research need. As part of the overall recovery effort, the U.S. Fish and Wildlife Service will take the lead in addressing this research need by forming a multi-agency technical team to develop protocols to evaluate trends in bull trout populations.

4. **Specific barriers to bull trout migration in the Lower Columbia Recovery Unit have been addressed.** The barriers that are identified as primary impediments to recovery and where connectivity must be reestablished are at Swift Dam (Number 1 and 2) and Yale Dam both on the Lewis River; and

Condit Dam on the White Salmon River. Identification of these barriers does not imply that other actions associated with passage (*e.g.*, culverts), habitat degradation, or nonnative species control are not crucial for recovery to occur.

Recovery criteria for the Lower Columbia Recovery Unit were established to assess whether recovery actions have resulted in the recovery of bull trout. The Lower Columbia Recovery Unit Team expects that the recovery process will be dynamic and require refinements as more information becomes available over time. The Lower Columbia Recovery Unit Team expects that the recovery process will be dynamic and will be refined as more information becomes available. While removal of bull trout as a species under the Endangered Species Act (*i.e.*, delisting) can only occur for the entity that was listed (Columbia River Distinct Population Segment), the recovery unit criteria listed above will be used to determine when the Lower Columbia Recovery Unit is fully contributing to recovery of the population segment.

Research Needs

Based on the best scientific information available, the Lower Columbia Recovery Unit Team has identified recovery criteria, and actions necessary for recovery of bull trout within the recovery unit. However, the recovery unit team recognizes that uncertainties exist regarding bull trout population abundance, distribution, and actions needed. The recovery team feels that if effective management and recovery are to occur, the recovery plan for the Lower Columbia Recovery Unit should be viewed as a "living" document and will incorporate new information, research findings, and recovery accomplishments. As part of this adaptive management approach, the recovery unit team has identified research needs which are essential within the recovery unit.

Bull Trout Distribution and Abundance

A key information gap and research need is to define the recovered distribution within the Lewis, White Salmon, and Klickitat rivers. A complete habitat suitability inventory needs to be conducted in order to determine if these areas meet

habitat requirements for bull trout. Within the Lewis, Speelyai, Rain, Ole creeks, and the upper mainstem Lewis River should be evaluated for their potential to support bull trout local populations.

Similarly, tributaries have been identified within the Klickitat system which provide basic cold water habitat conditions necessary for bull trout (WDFW 2000a). These streams include: Bird Creek, Hellroaring Creek, Big Muddy Creek, West Fork Klickitat River (Little Muddy Creek and Fish Lake Stream), Trappers Creek, Clearwater Creek, Crawford Creek, McCreedy Creek, Piscoe Creek, and Diamond Fork Creek. In addition, increased survey work is needed in the Cowlitz and Kalama rivers in order to determine if bull trout are present in these systems.

Historically, bull trout may have inhabited areas within the Cowlitz and Kalama rivers, but current distribution within the basin is unknown (WSCC 2000a; 2000b). The Cowlitz and Kalama rivers are considered research needs and additional information is required to determine if each respective system is important for bull trout recovery.

To assist in the identification of additional bull trout local populations, guidelines for evaluating habitat elements necessary for bull trout need to be updated, or in some cases developed. These guidelines should include recommendations on appropriate conditions associated with sediment delivery,
water temperature, physical habitat requirements (*e.g.*, large woody debris), instream flow, and normative hydrologic function.

After identification of additional local populations, studies to identify the habitat the productive capacity of each potential local population should be initiated. Comparisons of nearby bull trout watersheds (*e.g.*, Hood River) could be useful in evaluating the productive capabilities of potential local populations and core areas (*e.g.*, White Salmon River). In determining the recovered abundance, consideration of genetic risk, effective population size, and connectivity need to be incorporated with habitat productivity estimates in order to determine achievable abundance goals.

Columbia River

A primary research need is a more thorough understanding of the current, and future, role that the mainstem Columbia should play in the recovery of bull trout. Five adult bull trout have recently (1994 to 1998) been caught in the northern pikeminnow fishery conducted by the Washington Department of Fish and Wildlife in Bonneville Pool and the mainstem Columbia River below Bonneville Dam (Wachtel *in litt.* 2000). Older records have documented bull trout or Dolly Varden at Bonneville Dam and in the lower Columbia River near Jones Beach (Bonneville Fishway Report *in litt.* 1947; Catch Card Records *in litt.* 1966 to 1981). Historic records also indicate that bull trout used the lower mainstem Columbia River. Dolly Varden (bull trout) were caught in fishwheels operated on the mainstem Columbia in the late 1800's (Donaldson and Cramer 1971).

It seems likely that fluvial bull trout in the Lower Columbia Recovery Unit historically migrated to the mainstem Columbia River to overwinter and feed. Given that bull trout have been found in Drano Lake, below Condit Dam (most likely Hood River origin), and at the mouth of the Klickitat, similar use of the mainstem Columbia by adult bull trout from either the Lewis or White Salmon rivers might be expected if barriers were removed (WDFW 1998; Wachtel *in litt.* 2000).

Bull trout in other Columbia River tributaries (*e.g.*, Hood and Wenatchee rivers) are known to migrate downstream to the mainstem Columbia River as part of their normal life history strategies (ODFW 1997; Kelly-Ringel and De La Vergne 2001; Kreiter 2001). Uncertainty in the current use of the mainstem Columbia River by fluvial bull trout within the recovery unit has led the recovery team to identify the Columbia River as potential core habitat and as a primary research need. A better understanding of migration patterns between basins would greatly enhance the opportunities for recovery. The recovery team believes that migrational studies should be coordinated with the Hood River Unit in order to provide a more complete understanding of adult bull trout habitat requirements.

Monitoring and Evaluation

The Lower Columbia Recovery Unit Team realizes that recovery criteria will most likely be revised as recovery actions are implemented and bull trout populations begin to respond. In addition, the Lower Columbia Recovery Unit Team will rely on adaptive management to better refine both abundance and distribution criteria. Adaptive management is a continuing process of planning, monitoring, evaluating management actions, and research. This approach will involve a broad spectrum of user groups and will lay the framework for decision making relative to recovery implementation and ultimately, the possible revision of recovery criteria in this recovery unit.

This recovery unit chapter is the first step in the planning process for bull trout recovery in the Lower Columbia Recovery Unit. Monitoring and evaluation of population levels and distribution will be an important component of any adaptive management approach. The U.S. Fish and Wildlife Service will take the lead in developing a comprehensive monitoring approach which will provide guidance and consistency in evaluating bull trout populations. Development and application of models which assess extinction risk relative to abundance and distribution parameters are critical in refining recovery criteria as the recovery process proceeds. Application of agreed upon methods for evaluating recovery would benefit the scientific community and user groups alike.

Artificial Propagation

The Lower Columbia Recovery Unit Team has identified that reestablishment of local populations within the White Salmon and Klickitat rivers within 25 years may require the use of artificial propagation. Abundance in both the Klickitat and White Salmon rivers are extremely low, and natural recolonization may not occur within recovery time frames. Artificial propagation could involve the transfer of bull trout into unoccupied habitat within the historic range (ODFW 1997). In addition, artificial propagation could involve the use of Federal or State hatcheries to assist in recovery efforts (MBTSG 1996c). The Lower Columbia Recovery Team

recommends that studies be initiated to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery.

Any artificial propagation program instituted in the Lower Columbia Recovery Unit must follow the joint policy of the Fish and Wildlife Service and the National Marine Fisheries Service regarding controlled propagation of listed species (65 FR 56916). The overall guidance of the policy is that every effort should be made to recover a species in the wild before implementing a controlled propagation program. If necessary, an appropriate plan would need to be approved that considers the effects of transplantation on other species as well as the donor bull trout populations. Transplanting listed species must be authorized by the U.S. Fish and Wildlife Service and meet applicable State fish-handling and disease policies.

While artificial propagation has played an important role in the recovery of other listed fish species, where possible, the overall recovery strategy for bull trout in the Lower Columbia Recovery Unit will emphasize the removal of threats and habitat restoration. Recovery should emphasize identifying and correcting threats affecting bull trout and bull trout habitats. Artificial propagation programs should not be implemented unless reasons for decline have been addressed.

Genetic Studies

The Lower Columbia Recovery Unit Team recommends that studies be initiated to describe the genetic makeup of bull trout in the mainstem Columbia and Klickitat rivers. Genetic information for the Lewis Core Area has already been collected and analyzed (Spruell *et al.* 1998), and additional information from the Columbia and Klickitat rivers is necessary for a more complete understanding of bull trout interactions and population dynamics. In addition, a recovery unit wide evaluation of the current and potential threat of bull trout hybridization with brook trout is needed. The ability to evaluate the potential harm to specific local populations could be used in prioritizing management actions. Genetic baseline information would also be a necessity in the implementation of any artificial propagation program.

ACTIONS NEEDED

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follows a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are usually programmatic activities that are applicable across the species' range; they appear in *italic type*. These tasks may or may not have third-tier tasks associated with them; see Chapter 1 for more explanation. Some second-tier tasks may not be sufficiently developed to apply to the recovery unit at this time; they appear in *a shaded italic type (as seen here)*. These tasks are included to preserve consistency in numbering tasks among recovery unit chapters and intended to assist in generating information during the comment period for the draft recovery plan, a period when additional tasks may be developed. Third-tier entries are tasks specific to the Lower Columbia Recovery Unit. They appear in the implementation schedule that follows this section and are identified by three numerals separated by periods.

The Lower Columbia Recovery Unit should be updated or revised as recovery tasks are accomplished, or revised as environmental conditions change, and monitoring results or additional information become available. Revisions to the Lower Columbia Recovery Unit chapter will likely focus on priority streams or stream segments within core areas where restoration activities occurred, and habitat or bull trout populations have shown a positive response. The Lower Columbia Recovery Unit Team should meet annually to review annual monitoring reports and summaries, and make recommendations to the U.S Fish and Wildlife Service.

1 Protect, restore, and maintain suitable habitat conditions for bull trout.

1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.

1.1.1 **Conduct limiting factors analysis for water quality problems in the upper Klickitat River.** In cooperation with the Yakama Nation, conduct limiting factors analysis on Reservations Lands in the upper Klickitat River. This analysis should evaluate the impacts of roads, agricultural practices, and timber management on water quality in current or potential bull trout habitat. After study completion, prioritize areas for restoration activities.

1.1.2 **Improve water quality.** Implement restoration activities in Rush, Pine, and Cougar creeks to reduce sediment load, stabilize banks, and normalize peak flow events.

1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.

1.2.1 **Provide fish passage at Swift and Yale dams.** Evaluate passage options and implement actions necessary to restore two way passage at Swift (Number 1 and 2), Yale, and Merwin dams through the relicensing process. Passage at Swift (Number 1 and 2) and Yale dams is necessary to reconnect Cougar, Rush, and Pine creeks local populations. Reconnecting these populations is a Priority 1 action, and would allow for bull trout movement between reservoirs and would strengthen spawning populations in Cougar Creek.

1.2.2 **Provide fish passage at Condit Dam.** Coordinate with ongoing efforts to provide passage at Condit Dam on the White Salmon River. As part of the relicensing process PacifiCorp is considering removing the facility. Passage at Condit Dam is essential for reestablishing fluvial bull trout in the White Salmon River.

1.2.3 **Evaluate passage options of bull trout at Speelyai hatchery diversion.** Passage at the hatchery diversion would assist in

establishing an additional local population of bull trout in the Lewis River Core Area. Implement actions to provide passage if feasible.

1.2.4 **Reduce entrainment.** Quantify the level of entrainment at Yale Dam and Swift Dam (Number 1 and 2) and recommend actions to reduce impacts.

1.2.5 **Conduct limiting factors analysis for culvert problems.** Survey all culverts intersecting fish-bearing streams in the Lower Columbia Recovery Unit. Based on identification of additional local populations, implement programs to correct barrier problems. Surveys should include assessment of available habitat quantity and quality above the culvert to aid in prioritization of barrier correction.

1.2.6 **Conduct limiting factors analysis for instream flow problems.** Identify current and potential bull trout streams with instream flow problems and implement corrective actions (*e.g.*, Swift bypass reach) where feasible.

1.2.7 **Provide fish passage at Merwin Dam.** Partial passage currently exists at Merwin Dam and implementing actions to improve passage would allow bull trout access to the mainstem Columbia River for overwintering and feeding.

1.3 Identify impaired stream channel and riparian areas and implement tasks to restore their appropriate functions.

1.3.1 **Maintain current conservation practices on lower Rush Creek.** Rush Creek is the most important spawning area in the Lower Columbia Recovery Unit and maintaining quality habitat is essential for recovery.

1.3.2 **Protect and restore habitat in upper Rush and Pine creeks.** Implement habitat restoration activities in Rush and Pine watersheds to address problems with shading, slope stability, channel complexity and riparian revegetation.

1.3.3 **Collaborate with the Yakama Nation.** Work with Yakama Nation to assess habitat conditions and recommend restoration actions on reservation lands in the upper Klickitat watershed.

1.3.4 **Work with private landholders.** Work with private landholders (A and E Forest of Lewis River and Olympic Resources Group) to assess habitat conditions and recommend restoration actions where appropriate within Pine Creek drainage.

1.3.5 **Conduct limiting factors analysis for floodplain connectivity.** Conduct bull trout specific evaluation of limiting factors associated with floodplain connectivity and riparian condition in the Lewis and Klickitat core areas, the White Salmon core habitat, and the Cowlitz/Kalama watershed. Implement corrective actions where appropriate.

1.3.6 **Conduct limiting factors analysis for impact of roads.** Identify roads that are susceptible to mass wasting and bank failures, intercept surface or ground water, negatively impact riparian areas, and inhibit connectivity and natural stream function in the Lewis and Klickitat core areas, the White Salmon core habitat, and the Cowlitz/Kalama watershed. Implement corrective actions where appropriate.

1.4 Operate dams to minimize negative effects on bull trout in reservoirs and downstream.

1.5 Identify upland conditions negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

2 Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.

2.1 Develop, implement, and enforce public and private fish stocking policies to reduce stocking of nonnative fishes that affect bull trout.

2.2 Enforce policies for preventing illegal transport and introduction of nonnative fishes.

2.3 Provide information to the public about ecosystem concerns of illegal introductions of nonnative fishes.

2.4 Evaluate biological, economic, and social effects of control of nonnative fishes.

2.5 *Implement control of nonnative fishes where found to be feasible and appropriate.*

2.6 *Develop tasks to reduce negative effects of nonnative taxa on bull trout.*

3 Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.

3.1 Develop and implement State and Ttribal native fish management plans integrating adaptive research.

3.1.1 **Develop bull trout management plan.** Develop specific bull trout fishery management plan for core areas in the Lower Columbia Recovery Unit.

3.1.2 **Conduct assessment of nutrient levels and cycling**. Passage barriers on the Lewis and White Salmon rivers prevent anadromous salmon and steelhead from volitionally entering these systems and may have negatively impacted nutrient levels and natural cycling.

3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.

3.2.1 **Provide information to anglers.** Provide information to anglers about bull trout identification, special regulations, fisheries management of endangered species, and how to reduce hooking mortality of bull trout caught incidentally in recreational fisheries.

3.2.2 **Investigate and minimize incidental or illegal catch of bull trout.** Investigate and minimize incidental catch of bull trout by increasing enforcement in the Lewis (*e.g.*, below Eagle Cliff Bridge) and Klickitat rivers; below Condit Dam on the White Salmon River; and the Bonneville Pool sport fishery specifically at Drano Lake. Increasing information signs at Drano Lake and the Klickitat River. Increase outreach activities, informational signs, and regulation changes when necessary.

3.2.3 **Address road access impacts.** Identify roads that may facilitate poaching for bull trout in the Lewis River above Swift Creek Reservoir and restrict access where appropriate.

3.2.4 **Evaluate impacts of fishing regulations.** Evaluate, and recommend changes if necessary, for current fishing regulations on bull trout in the area below Eagle Cliff Bridge to prevent incidental and illegal harvest.

3.3 Evaluate potential effects of introduced fishes and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.

3.3.1 **Assess impact of nonnative species.** Assess impact of nonnative species (*e.g.*, brook trout) on bull trout within core areas of the Lower Columbia Recovery Unit and develop priorities, strategies and cost estimates for control.

3.3.2 **Reduce and/or control nonnative species.** Based on 3.3.1, where appropriate institute measures to control and reduce nonnative species numbers and interactions with bull trout.

3.3.3 **Investigate ecological interactions.** Investigate ecological interactions among bull trout, northern pikeminnow, and tiger musky in Lake Merwin, and interactions between bull trout and hatchery salmon below Condit Dam.

3.4 *Evaluate effects of existing and proposed sport fishing regulations on bull trout.*

4 Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.

4.1 Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.

4.2 Maintain existing opportunities for gene flow among bull trout populations.

4.3 Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.

4.3.1 **Develop and establish genetic protocols.** Establish genetic reserve protocols and standards for initiating, conducting, and evaluating artificial propagation programs for bull trout.

4.3.2 **Establish genetic baselines.** Genetic baseline descriptions of bull trout in the Columbia and Klickitat rivers are essential for a complete understanding of bull trout interactions and population dynamics.

4.3.3 **Evaluate hybridization with brook trout.** Recovery unit-wide evaluation of the current and potential threat of bull trout hybridization with brook trout is needed. The ability to evaluate the potential harm to specific local populations can be used in prioritizing management actions.

4.3.4 **Conduct feasibility study on artificial propagation in the White Salmon and Klickitat basins.** Reestablishment of local populations within the White Salmon and Klickitat rivers may require the use of artificial propagation. The Lower Columbia Recovery Team recommends that studies be initiated to determine the effectiveness and feasibility of using fish transfers and hatcheries to assist in any future reintroduction efforts.

4.3.5 **Conduct artificial propagation where deemed necessary and appropriate (using results from task 4.3.4).**

5 Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.

5.1 *Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.*

5.2 Conduct research evaluating relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.

5.2.1 **Standardize and implement sampling protocol for bull trout, particularly in the Lewis, White Salmon, and Klickitat basins.** Support ongoing efforts through the American Fisheries Society to develop methods and protocols for detection of bull trout. Additional data is needed to refine and clarify the recovered distribution of bull trout in the Lower Columbia Recovery Unit.

5.2.2 **Develop and implement habitat guidelines.** Develop and implement guidelines for bull trout that restore or maintain habitat elements (*e.g.*, sediment delivery, water temperature, normative hydrologic function) to provide for recovery. These guidelines will be used to help identify areas within the White Salmon and Klickitat rivers which could support local populations of bull trout.

5.3 Conduct evaluations of the adequacy and effectiveness of current and past Best Management Practices in maintaining or achieving habitat conditions conducive to bull trout recovery.

5.4 *Evaluate effects of diseases and parasites on bull trout, and develop and implement strategies to minimize negative effects.*

5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

5.5.1 **Conduct fish surveys.** Expanded fish surveys are needed in the Cowlitz and Kalama rivers to determine if bull trout are present.

5.5.2 **Identify potential local populations**. Investigate temperature profile, flow regime, and habitat characteristics of Lewis tributaries (Speelyai, Rain, Ole creeks), White Salmon River tributaries, and Klickitat River tributaries (*e.g.*, Diamond Fork) for the potential to establish local populations. Identification of potential tributaries which could support local populations is necessary in order to refine the recovered distribution of bull trout and is considered a priority 1 action. Use guidance from task 1.3.5.

5.6 Identify evaluations needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.

6 Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.

6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

6.1.1 **Support collaborative efforts by local watershed groups**. Support collaborative efforts by local watershed groups to improve water quality and accomplish site specific habitat protection and restoration activities in the Lewis and Klickitat core areas. Similar actions should be conducted in the White Salmon River. Provide incentives and support development of Habitat Conservation Plans and Safe Harbor Agreements.

6.1.2 **Protect habitat.** Provide long-term habitat protection through purchase from willing sellers, land exchange, conservation easements, managements, with initial emphasis on identified bull trout spawning and rearing streams. Emphasis should be placed on areas within the Klickitat and White Salmon rivers.

Coordinate with local governments and watershed councils to identify opportunities.

6.1.3 **Coordinate recovery efforts**. Coordinate bull trout recovery activities with Federal, State, and Tribal anadromous fish reintroductions and recovery plans.

6.2 Use existing Federal authorities to conserve and restore bull trout.

6.2.1 **Participate in relicensing activities.** Complete relicensing of Swift, Yale, Merwin, and Condit dams and implement appropriate mitigation activities.

6.3 Enforce existing Federal and State habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.

6.3.1 **Continue management of U.S. Forest Service lands under Northwest Forest Plan and INFISH.** Continue restoration activities in key and priority watersheds, development of watershed analyze, and support long-term monitoring to ensure conservation of bull trout.

6.3.2 **Coordinate with State bull trout management plans.** Incorporate bull trout recovery actions into updated Washington State bull trout management plans to ensure consistency.

7 Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

7.1 Convene annual meetings of each recovery unit team to generate progress reports on implementation of the recovery plan for the U.S. Fish and Wildlife Service.

7.2 Develop and implement a standardized monitoring program to evaluate the effectiveness of recovery efforts (coordinate with 5.1).

7.3 Revise scope of recovery as suggested by new information.

7.3.1 **Periodically review progress toward recovery goals and assess recovery task priorities.** Annually review progress toward population and adult abundance criteria and recommend changes, as needed, to the Lower Columbia Recovery Unit Chapter. In addition, review tasks, task priorities, completed tasks, budget, time-frames, particular successes, and feasibility within the Lower Columbia Recovery Unit. Updates must include identification of additional local populations in the Lewis, Klickitat, and White Salmon rivers and feasibility analysis on use of Federal and State hatcheries in artificial propagation for reintroduction efforts in the Lower Columbia Recovery Unit.

IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows describes recovery task priorities, task numbers, task descriptions, duration of tasks, potential or participating responsible parties, total cost estimate and estimates for the next 5 years, if available, and comments. These tasks, when accomplished, will lead to recovery of bull trout in the Lower Columbia Recovery Unit.

Parties with authority, responsibility, or expressed interest to implement a specific recovery task are identified in the Implementation Schedule. Lead parties are designated in bold type. Listing a responsible party does not imply that prior approval has been given or require that party to participate or expend any funds. However, willing participants will benefit by demonstrating that their budget submission or funding request is for a recovery task identified in an approved recovery plan, and is therefore part of a coordinated recovery effort to recover bull trout. In addition, section 7(a)(1) of the Endangered Species Act directs all Federal Agencies to use their authorities to further the purposes of the Act by implementing programs for the conservation of threatened or endangered species.

Following are definitions to column headings and keys to abbreviations and acronyms used in the Implementation Schedule:

Priority Number: All priority 1 tasks are listed first, followed by priority 2 and priority 3 tasks.

Priority 1: All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: All actions that must be taken to prevent a significant decline in species population, habitat quality, or some other significant negative effect short of extinction.

Priority 3: All other actions necessary to provide for full recovery (or reclassification) of the species.

Task Number and Task Description: Recovery tasks as numbered in the recovery outline. Refer to the action narrative for task descriptions.

Task Duration: Expected number of years to complete the corresponding task. Study designs can incorporate more than one task, which when combined can reduce the time needed for task completion.

Responsible or Participating Party: The following organizations are those with responsibility or capability to fund, authorize, or carry out the corresponding recovery task. Lead agencies are indicated in bold type. Additional identified agencies or parties are considered cooperators in restoration efforts. Identified parties include:

USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Nation
WDNR	Washington Department of Natural Resources
BPA	Bonneville Power Administration
PC	PacifiCorp
FERC	Federal Energy Regulatory Commission
WDOE	Washington Department of Ecology
EPA	Environmental Protection Agency
USFS	U.S. Forest Service
WSCC	Washington State Conservation Commission

Cost Estimates: Cost estimates are rough approximations and provided only for general guidance. Total costs are estimated for the duration of the task, are itemized annually for the next 5 years, and includes estimates of expenditures by local, Tribes, State, and Federal governments and by private business and individuals.
An asterisk (*) in the total cost column indicates ongoing tasks that are currently being implemented as part of normal agency responsibilities under existing authorities. Because these tasks are not being done specifically or solely for bull trout conservation, they are not included in the cost estimates. Some of these efforts may

be occurring at reduced funding levels and/or in only a small portion of the watershed.

Double asterisk (**) in the total cost column indicates that estimated costs for these tasks are not determinable at this time. Input is requested to help develop reasonable cost estimates for these tasks.

Triple asterisk (***) indicates costs are combined with or embedded within other related tasks.

Implementation schedule for the Bull Trout Recovery Plan: Lower Columbia Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	1.1.1	Conduct limiting factors analysis for water quality problems in the upper Klickitat River	2	**YN,** WDNR, UC, USFS, WDFW	100	50	50				
1	1.2.1	Provide fish passage at Swift (Number 1 and 2) and Yale dams	3	**PC**, USFWS	600	200	200	200			
1	1.2.2	Provide fish passage at Condit Dam	6	**PC**, **USFWS**	60	10	10	10	10	10	
1	1.2.5	Conduct limiting factors analysis for culvert problems	3	**WDNR,** WDFW, YN, USFS	75	25	25	25			
1	1.2.6	Conduct limiting factors analysis for instream flow problems	3	**WDNR, WDFW, YN,** USFS, USFWS	75	25	25	25			
1	1.3.1	Maintain current conservation practices on lower Rush Creek	25	**USFS**	*						Ongoing[2]
1	1.3.2	Protect and restore habitat in upper Rush and Pine creeks	10	**USFS**, USFWS	500	50	50	50	50	50	

[2]Ongoing tasks are currently being implemented as part of normal agency responsibilities that may benefit bull trout. Because these actions are not specifically being done to address bull trout conservation, they are not included in the cost estimates. Some of these efforts may be occurring at reduced funding levels and/or in only a small portion of the watershed.

Implementation schedule for the Bull Trout Recovery Plan: Lower Columbia Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
1	1.3.3	Collaborate with the Yakama Nation	3	**YN, USFWS**, USFS	30	10	10	10			
1	1.3.5	Conduct limiting factors analysis for floodplain connectivity	3	**WDNR, WDFW, YN**	75	25	25	25			
1	1.3.6	Conduct limiting factors analysis for impact of roads	3	**USFS, WDNR, YN**	75	25	25	25			
1	3.2.3	Address road access impacts	3	**USFS**	30	10	10	10			
1	4.3.2	Establish genetic baselines	3	**WDFW, YN,** USFWS	180	70	100	10			
1	5.2.2	Develop and implement habitat guidelines	5	**USFWS**, WDFW, USFS, PC	180	60	60	20	20	20	
1	5.5.2	Identify potential local populations	2	**PC**, WDFW, USFWS	300	150	150				
1	6.1.2	Protect habitat	10	**WDNR,** WDFW, USFWS,USFS	2000	200	200	200	200	200	
2	1.1.2	Improve water quality	10	**USFS**	1000	100	100	100	100	100	

Implementation schedule for the Bull Trout Recovery Plan: Lower Columbia Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	1.2.3	Evaluate passage options of bull trout at Speelyai hatchery diversion	2	**PC**, WDFW	40	20	20				
2	1.2.4	Reduce entrainment	8	**PC**, USFWS	*						Ongoing
2	1.2.7	Provide fish passage at Merwin Dam	3	**PC**, USFWS	300	100	100	100			
2	1.3.4	Work with private landholders	2	**USFWS**, **Private Land Holders**	50	25	25				
2	3.1.1	Develop bull trout fishery management plan	3	**WDFW, YN**	75	25	25	25			
2	3.2.4	Evaluate impacts of fishing regulations	3	**WDFW**	30	10	10	10			
2	3.3.1	Assess impact of nonnative species	3	**WDFW, YN,** USFWS, USFS	150	50	50	50			
2	3.3.2	Reduce and/or control spread of nonnative species	25	**WDFW, YN**	***						Cost estimate dependent upon 3.3.1
2	3.3.3	Investigate ecological interactions	3	**WDFW,YN** USFWS,	300	100	100	100			

Implementation schedule for the Bull Trout Recovery Plan: Lower Columbia Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
2	4.3.4	Conduct feasibility study on artificial propagation in the White Salmon and Klidkitat basins	3	**USFWS,** WDFW, YN	10	5	5				
2	4.3.5	Conduct artificial propagation where deemed necessary and appropriate	3	**USFWS,** WDFW, YN	20		10	10			
2	5.2.1	Standardize and implement sampling protocol for bull trout	5	**USFWS**, PC, WDFW	140	60	20	20	20	20	
2	6.3.2	Coordinate with State bull trout management plans	5	**WDFW**, USFWS	*						Ongoing
3	3.1.2	Conduct assessment of nutrient levels and cycling	3	**PC, WDFW,** USFS, USFWS	60	30	30	30			
3	3.2.1	Provide information to anglers	3	**WDFW**	30	10	10	10			
3	3.2.2	Investigate and minimize incidental or illegal catch of bull trout	3	**WDFW**	225	75	75	75			
3	4.3.1	Develop genetic protocols	3	**USFWS,** WDFW, YN	*						Ongoing
3	4.3.3	Evaluate hybridization with brook trout	3	**WDFW**, **USFS** USFWS,	*						Ongoing

Implementation schedule for the Bull Trout Recovery Plan: Lower Columbia Recovery Unit											
Priority number	Task number	Task description	Task duration (years)	Responsible parties	Cost estimates ($1,000)						Comments
					Total cost	Year 1	Year 2	Year 3	Year 4	Year 5	
3	5.5.1	Conduct fish surveys	5	**WDFW, USFS,** USFWS	100	20	20	20	20	20	
3	6.1.1	Support collaborative efforts by local watershed groups	5	**USFWS,** UC, WDFW, USFS, YN	1000	200	200	200	200	200	
3	6.1.3	Coordinate recovery efforts	5	**USFWS**, NMFS, WDFW, YN	250	50	50	50	50	50	
3	6.2.1	Participate in relicensing activities	5	**USFWS, PC**	*						Ongoing
3	6.3.1	Continue management of U.S. Forest Service lands under Northwest Forest Plan and INFISH	25	**USFS**	*						Ongoing
3	7.3.1	Periodically review progress toward recovery goals and assess recovery task priorities	25	**USFWS**	*						Ongoing

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APPENDIX A

Chapter 1 - Introductory
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Chapter 3 - Clark Fork River Recovery Unit, Montana, Idaho, and Washington
Chapter 4 - Kootenai River Recovery Unit, Montana and Idaho
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